Mechanical World
AND ENGINEERING RECORD
Monthly: Two Shillings and Sixpence Established 1876 AUGUST, 1960

One of the hundreds of Gamax Gear Units installed in the factory of W. D. & H. O. Wills

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THE GREAT LITTLE Gear Unit

gives smooth, efficient service in light industry

For packaging cigarettes and for almost any other light industrial tasks requiring a range of ½ to 1½ max. H.P. (18–896 r.p.m. output speed) these compact Gamax Gear Units excel. Incorporating straight line drive with high quality Durangus non-metallic planet pinions they provide really silent, vibration-free operation . . . *and because conventional oilbath lubrication is completely dispensed with, all fear of leakage or contamination is eliminated.* The sealed bearing assembly is prepacked with grease to ensure at least two years trouble free running under normal conditions . . . and these compact units can be mounted at *any* angle without in any way impairing their efficiency. Competitive in price, these outstanding gear units are available to give efficient, quiet and trouble-free service in any light industrial application.

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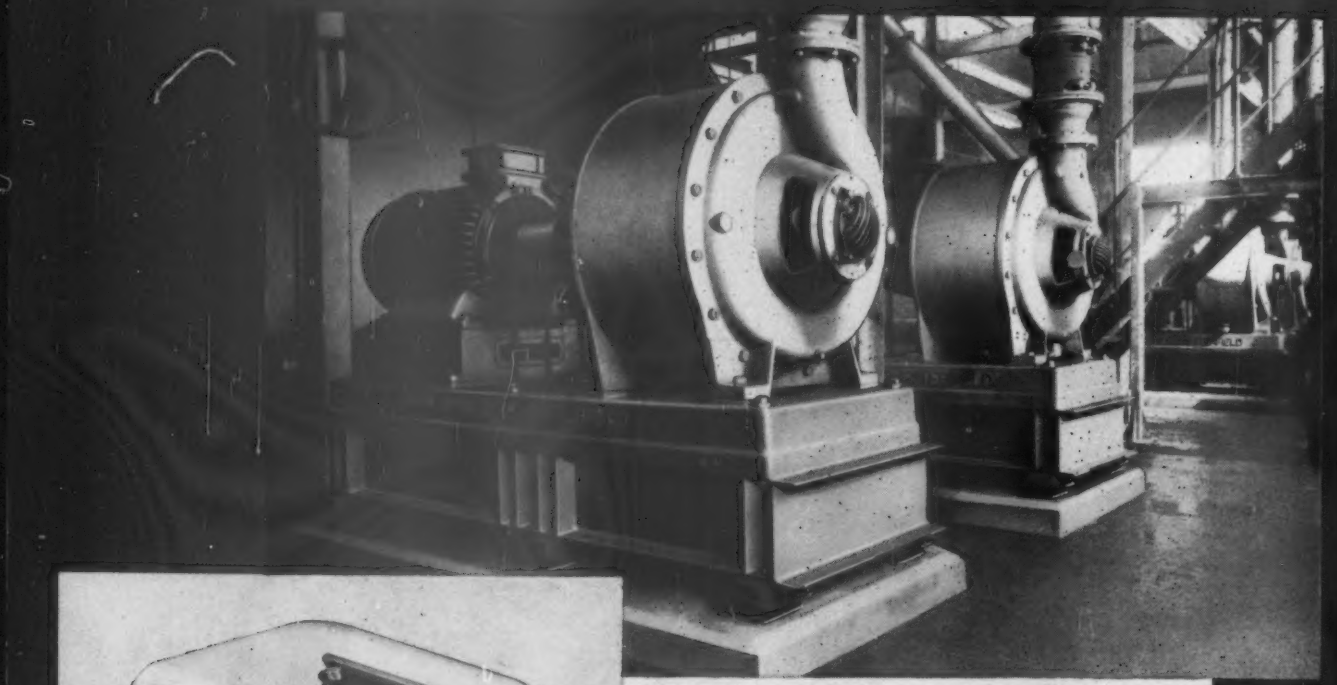
A53/60



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METALASTIK

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A9/59

Maxgrip belting cuts out pulley slip because its driving ply, even when worn, has a consistently high coefficient of friction. This pulley-gripping ply is made from cotton yarns and rubber latex spun together in a vacuum—*each individual fibre of cotton is fully coated with natural rubber.* This enables Maxgrip belting to be run at a lower tension, greatly reducing pulley shaft wear and fastener strain. Maxgrip will always transmit 15% more power at 180° arc of contact than its equivalent in conventional belting.

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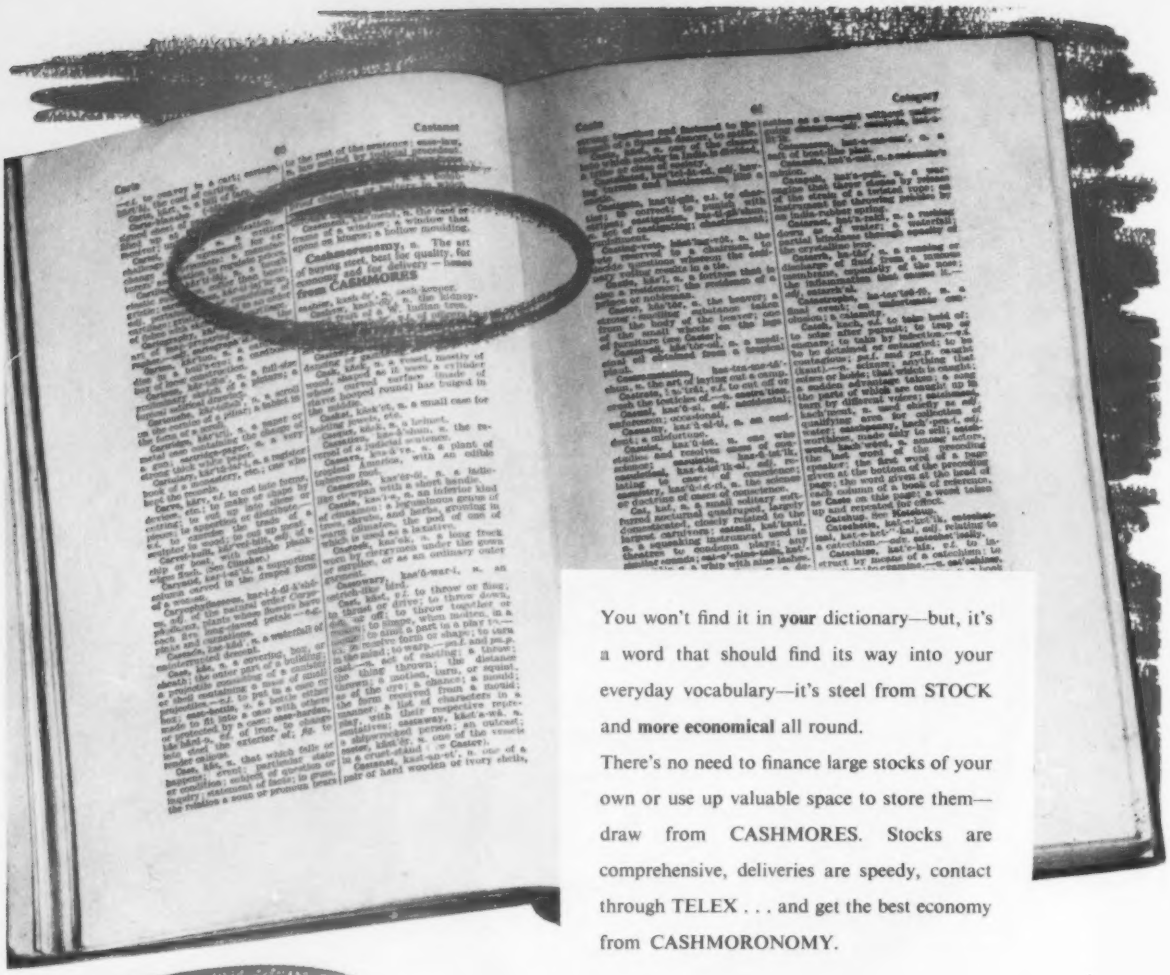

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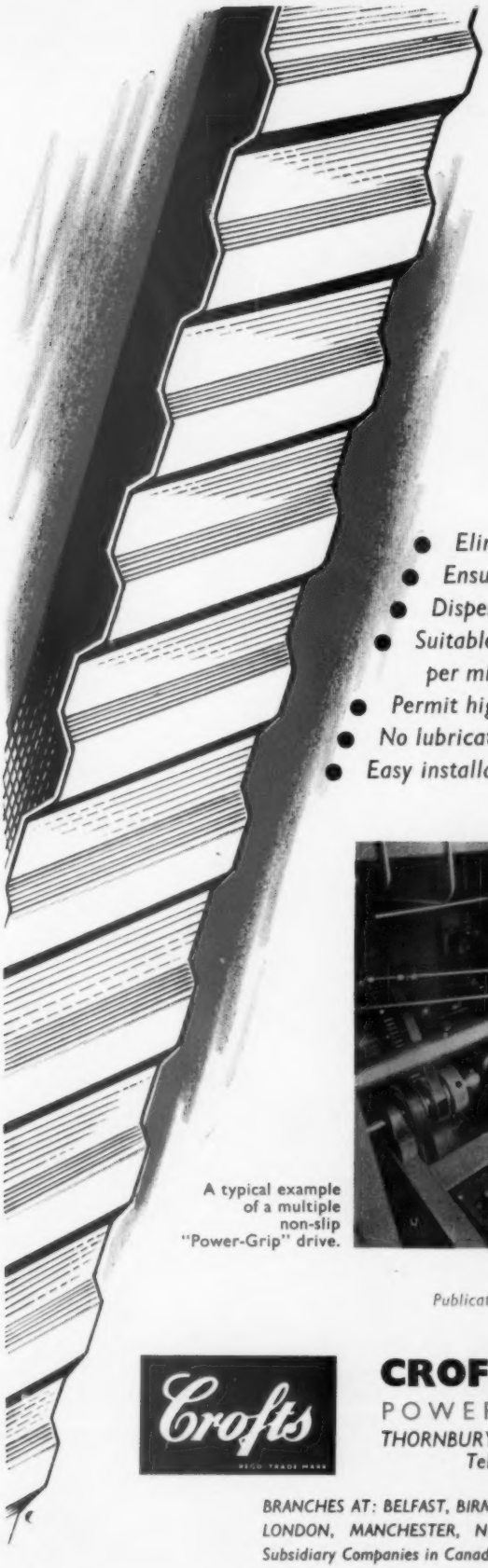

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PRECISION BELT DRIVES EX STOCK FROM CROFTS

- *Eliminate slip or power loss.*
- *Ensure more accurate timing of synchronized drives.*
- *Dispense with tensioning devices.*
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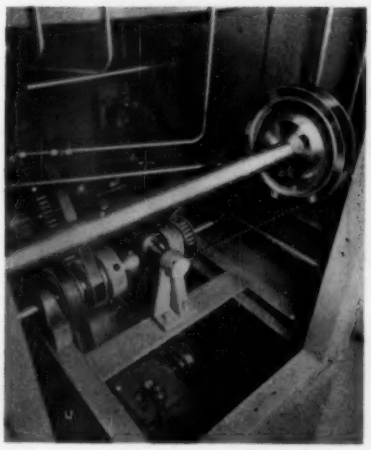

A typical example of a multiple non-slip "Power-Grip" drive.

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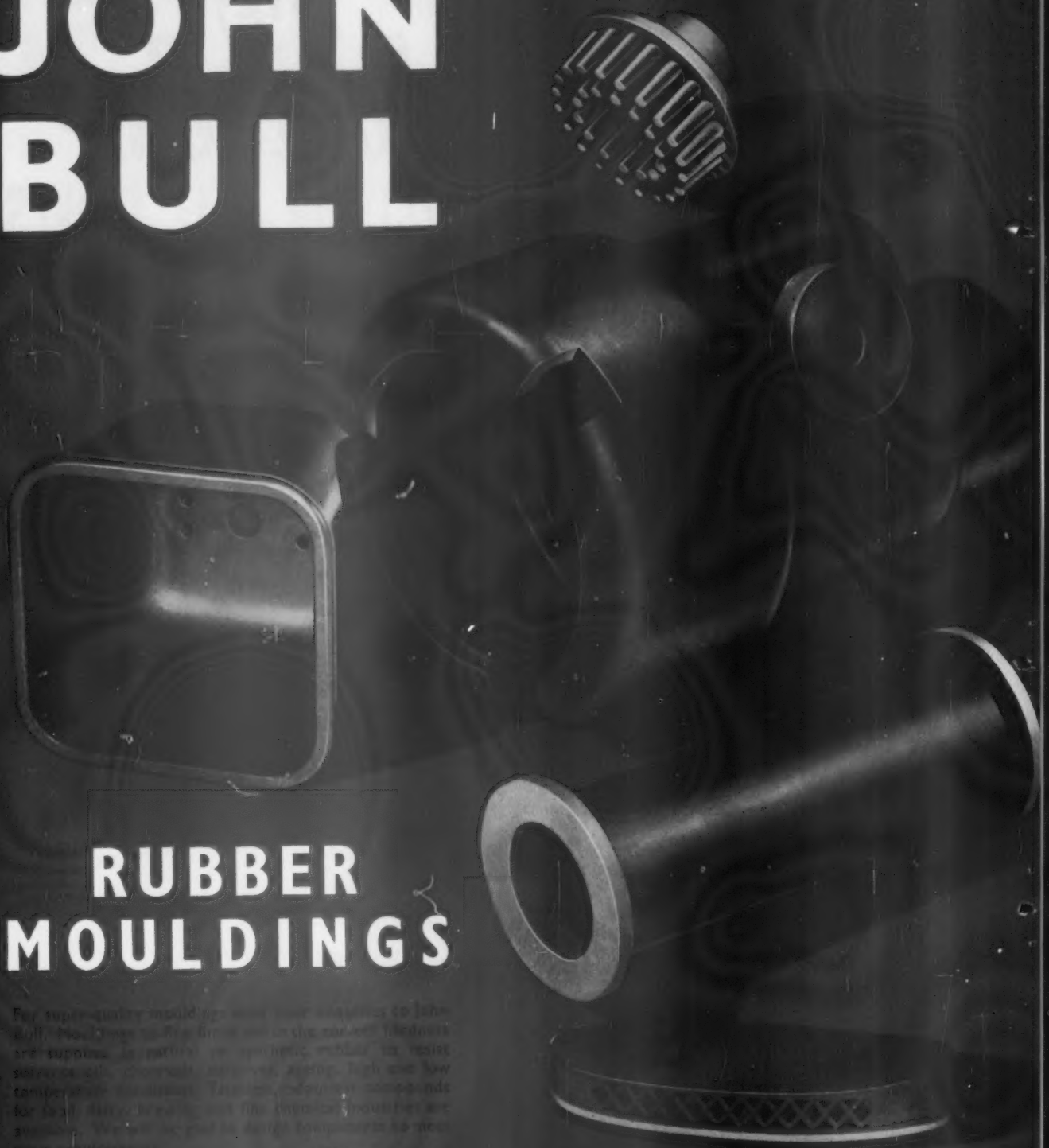

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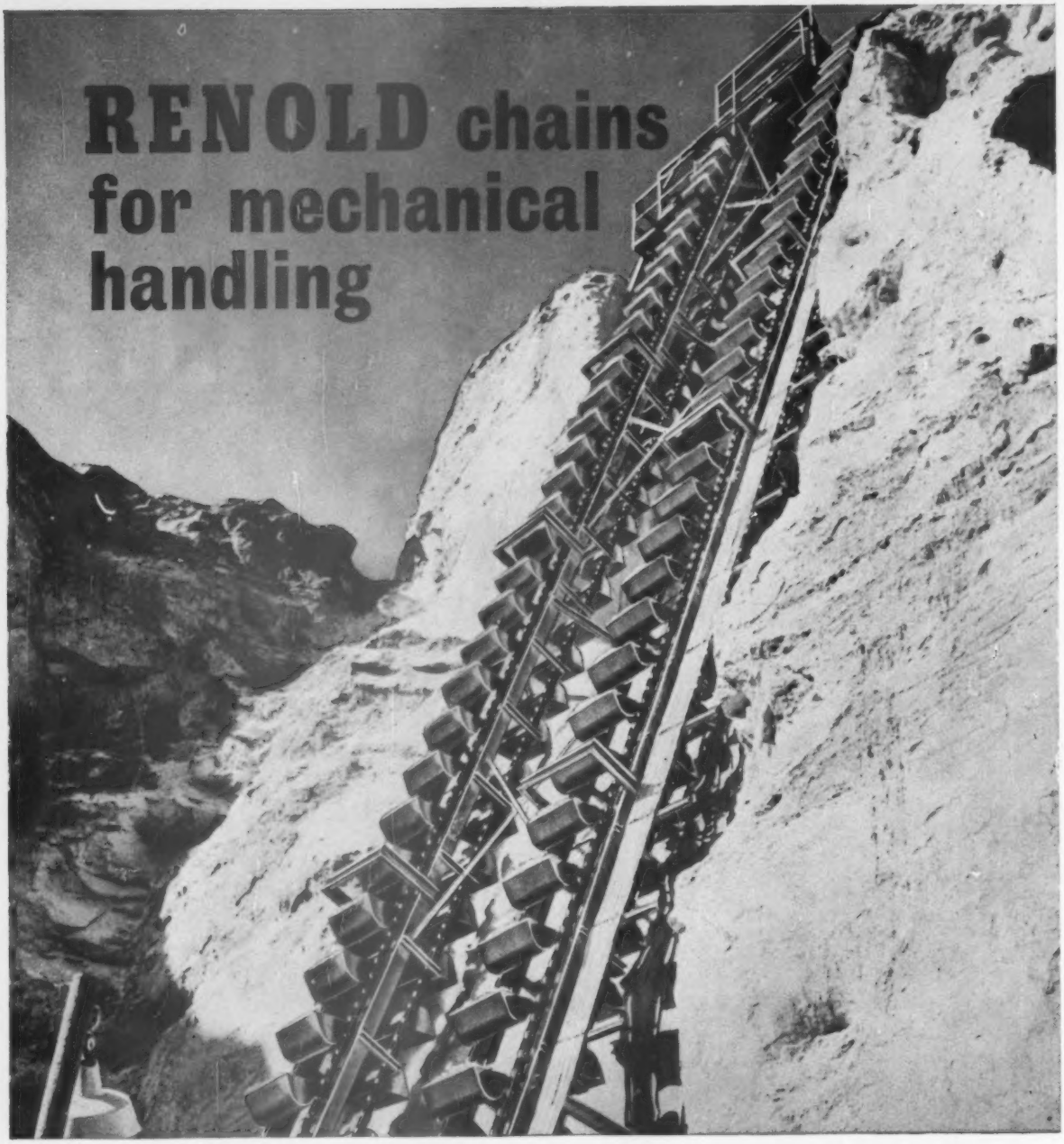

Quarries are the scene of some of man's most impressive undertakings: here are found mammoth machines and plant on a huge scale. Renold chains, of the heaviest and most rugged designs, are widely employed and make a notable contribution to the success and efficiency of the industry.

Renold chains are everywhere.

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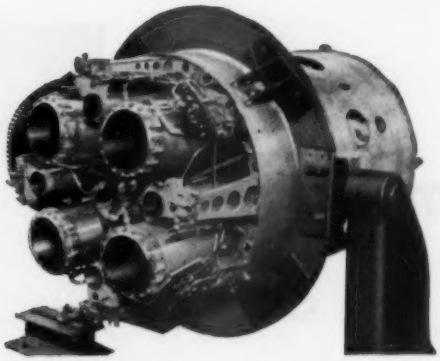
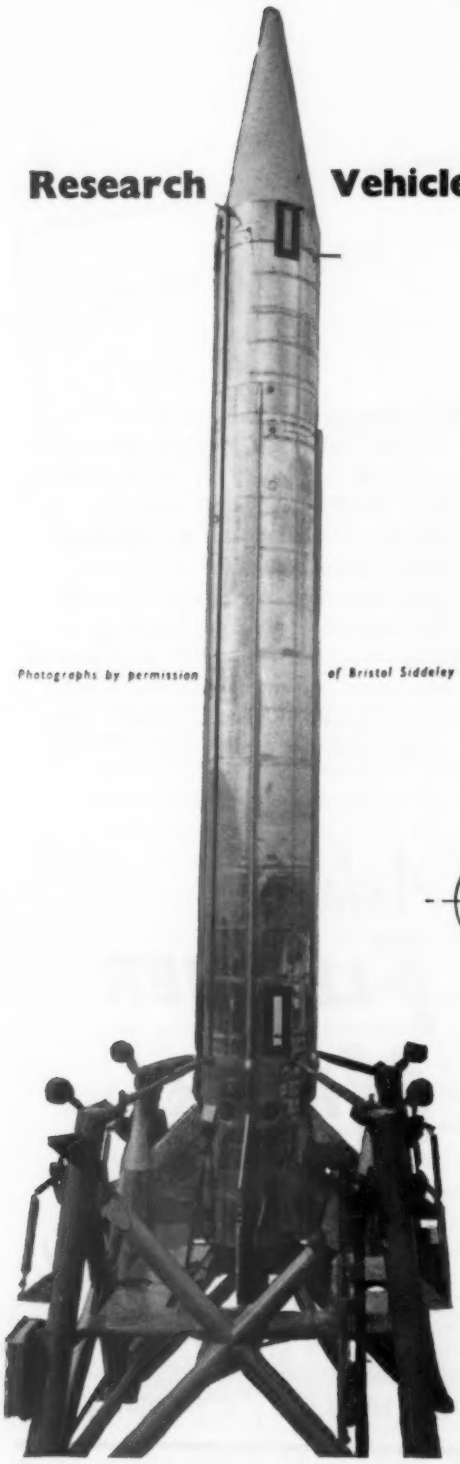


Research Vehicle engines use the Belleville Washer

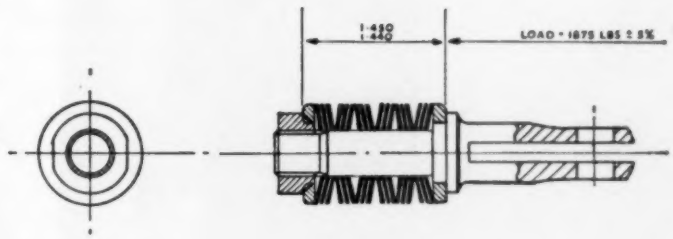


Photographs by permission of Bristol Siddeley Engines

When the Black Knight Rocket roars 150 miles up into space it is guided by the swivelling through an angle of the four combustion chambers of the Gamma engine. An efficient damping mechanism is needed to prevent damage when the limit stop is reached.

Belleville washers provide the perfect answer to the problem.

Belleville washers are solving design difficulties in every industry where resistance to exceptionally heavy loads is beyond the capacity of helical springs and particularly where movement under shock or sustained load must be restricted to very fine limits. Salter technicians can help you. Their services are freely at your disposal.



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"dag" colloidal graphite is incorporated in the asbestos-type bearings manufactured at the High Wycombe Works of Railko Limited. One stage of production is illustrated.

lubricants for brake linings ?

No, not really. But manufacturers of bearings made from resin-bonded asbestos—commonly used for brake linings—do incorporate "dag"* colloidal graphite in their products. Why? Because the fineness and stability of the particles in any Acheson dispersion ensure that the inherent properties of graphite are imparted to the material. Acheson dispersions may be impregnated or incorporated into fibres, leather, cloth, wood, paper and many other substances. "dag" colloidal graphite is heat-resisting, chemically inert, friction and therefore wear-reducing, electrically conducting and an excellent "parting" agent. These are the reasons why it is used extensively in industry as an integral part of, for instance, non-metallic bearings, packings, conducting textile tapes and braids, resistance heating panels of many types. If the possibilities interest you, write to the first and foremost manufacturers of colloidal graphite for specific recommendations.

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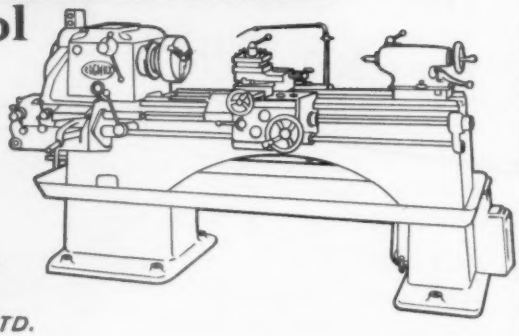

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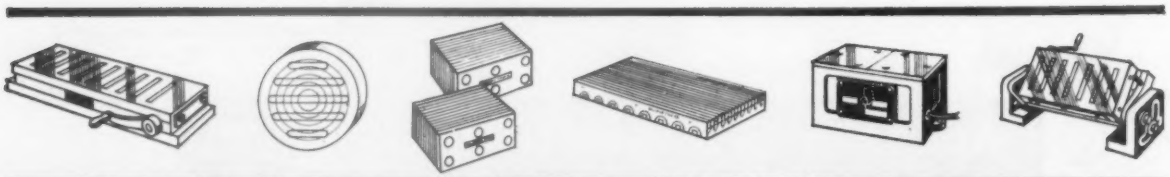

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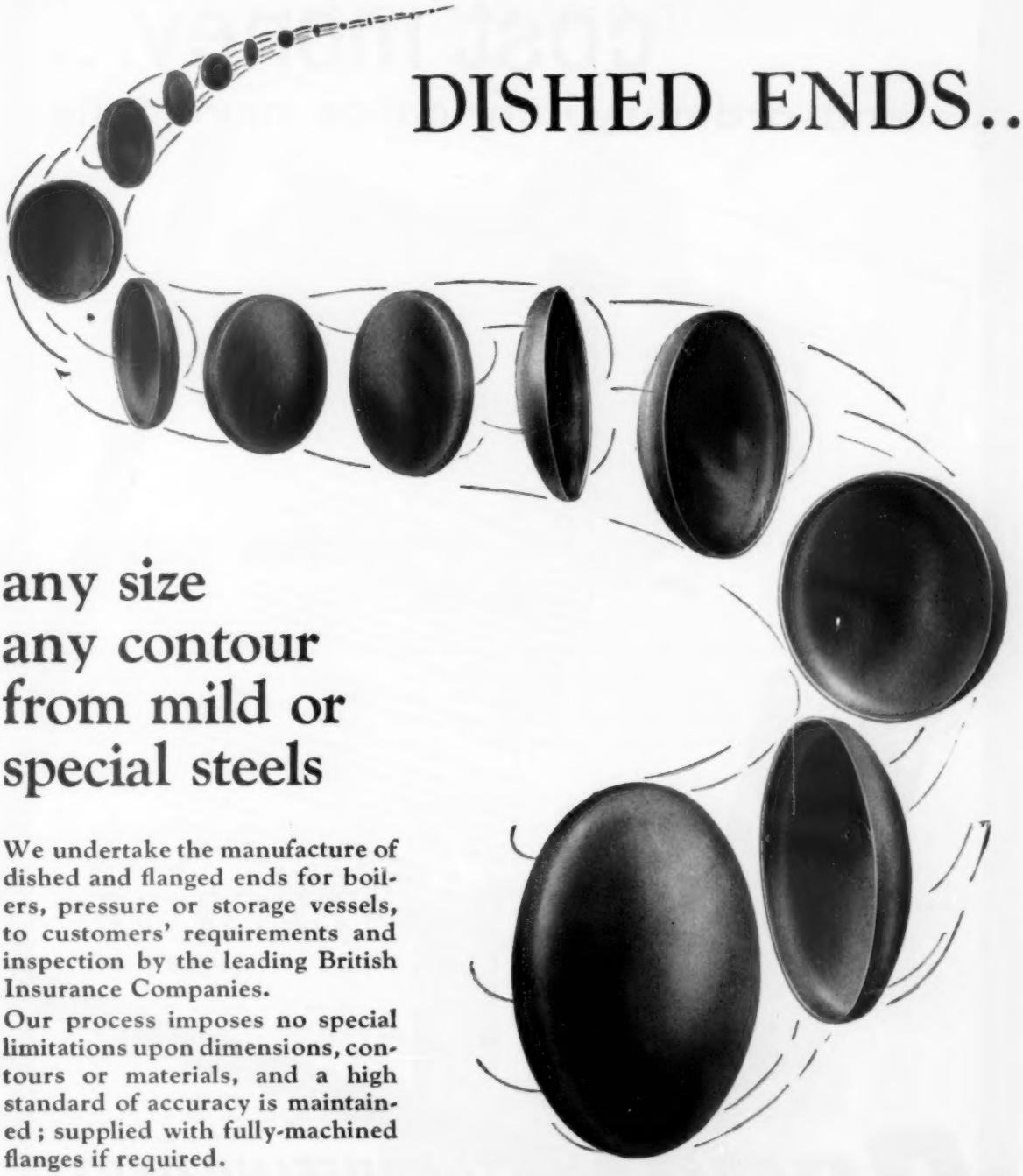

any size
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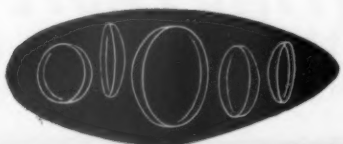

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Problem: Each cut taken needed from 6½ to 8 hours. Various orthodox centre lubricants such as white-lead & oil, white-lead and graphite, grease & graphite, oil & graphite, etc., were tried. None of these were satisfactory. After about 40 minutes slight centre squealing began and after about one hour the job could not proceed without replenishing lubricant. To do this it was essential to support workpiece and wind out centre. In addition, damage occurred to centre, necessitating several removals for reconditioning.

As eight cylinders had to be machined, the above circumstances became quite intolerable.

Solution: A two-ounce tube of Rocol Anti-Scuffing Paste. When this lubricant was tried in accordance with the manufacturer's instructions it became possible to run the cylinder on centres for from 16 to 23 hours. In most cases, therefore, several cuts could be taken without interruption.

Conclusion: Only one two-ounce tube of Rocol Anti-Scuffing paste was needed for eight Cylinders. We regard this as a truly marvellous performance, and we are now using the paste as a standard centre lubricant for all kinds of work.

Director

March 1960

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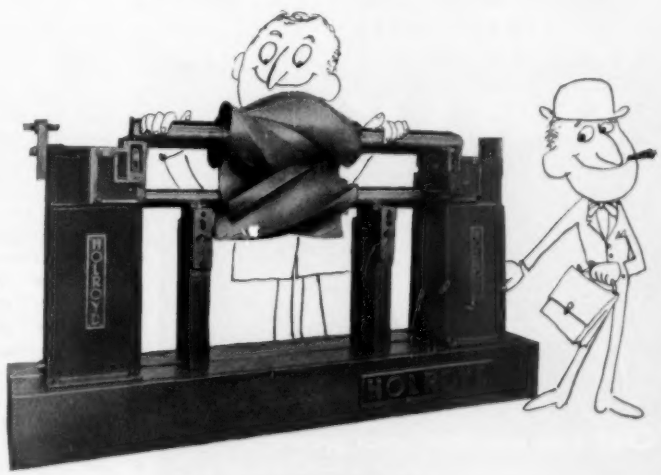

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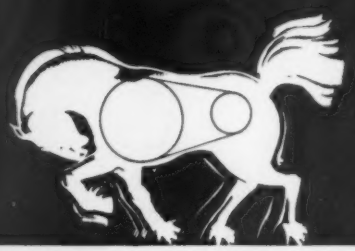

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- Constant pitch diameters at all loads are maintained on "POLY-V" Drives.
- "POLY-V" Drives ensure minimum vibration and cooler running.
- "POLY-V" Drives provide greater interchangeability of belts and pulleys because there are only two belt cross sections instead of five for multiple V-belt drives.
- Longer lives of belts and pulleys are obtained on "POLY-V" Drives.
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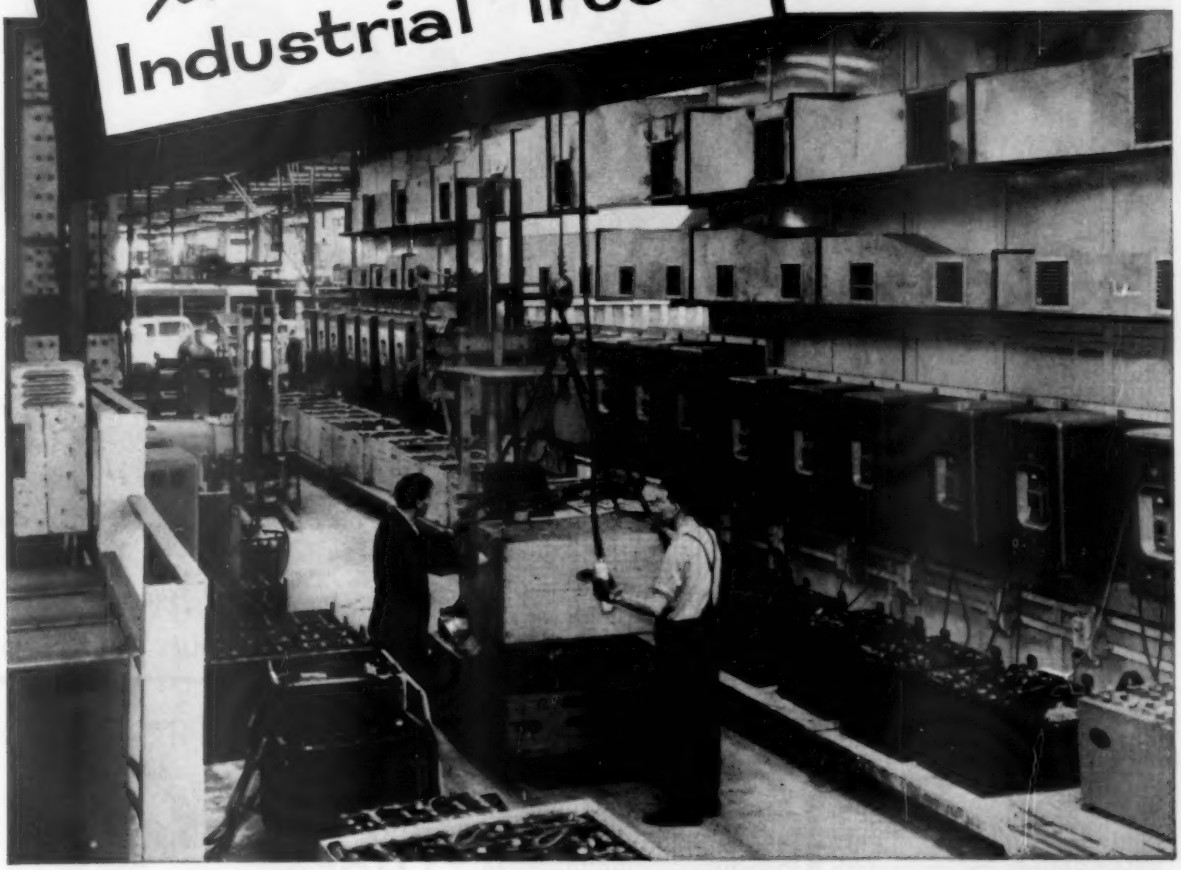

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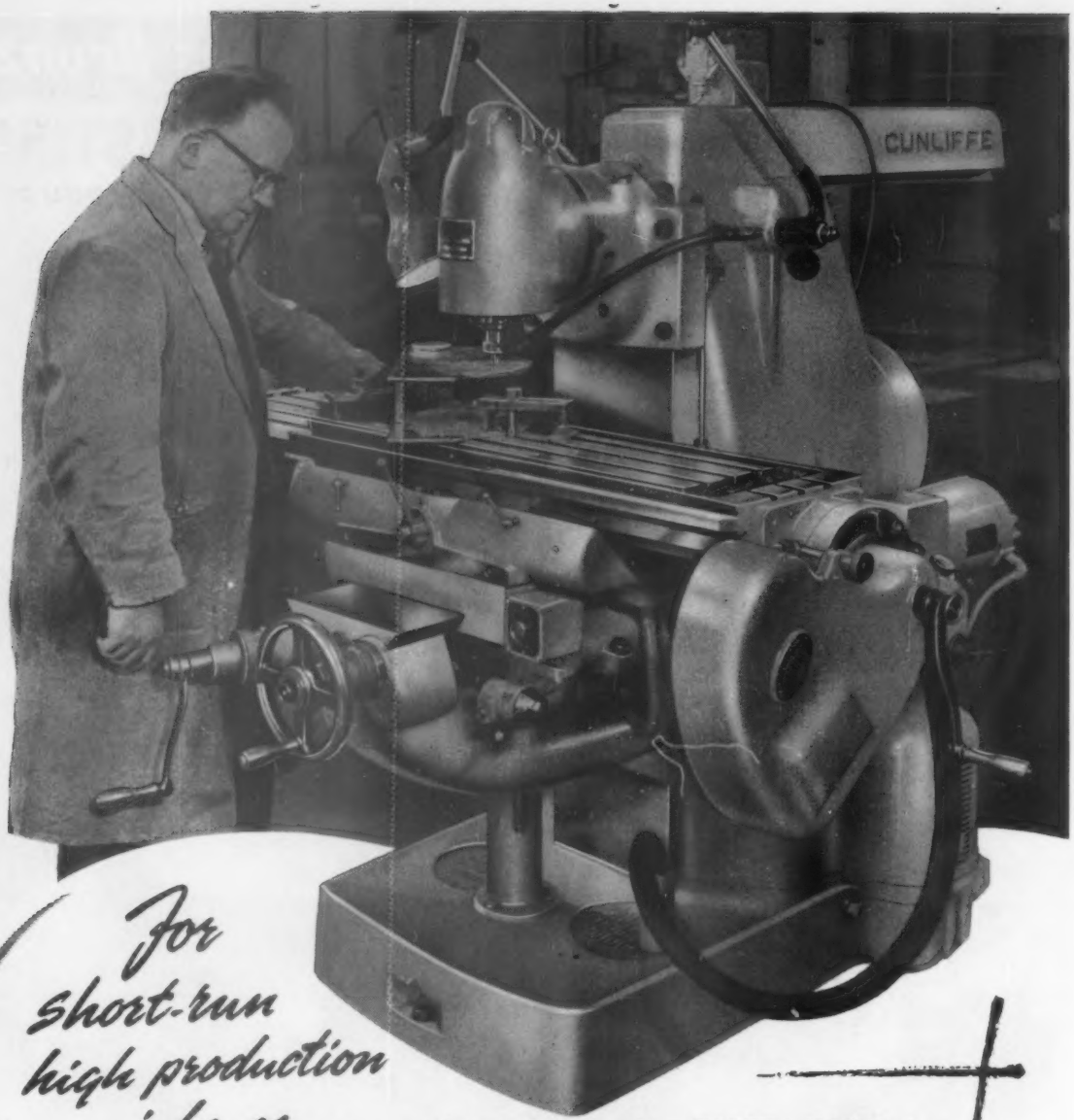

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Mechanical World

AND ENGINEERING RECORD

Vol. 140 AUGUST, 1960 Number 3493

Contents

MECHANICAL WORLD AND ENGINEERING RECORD is published monthly in Manchester and London.
MANCHESTER: 31 King Street West, 3.
Telephone: BLAckfriars 7086.
Telegrams: Textile, Manchester.
LONDON: 158 Temple Chambers, Temple Avenue, EC4.
Telephone: FLEet Street, 8914.

Subscriptions. The annual subscription rate throughout the world is 30/- post free. Subscription orders may be sent to the publishers at either of the addresses given above, or placed through any newsagent or subscription agency. The price of single copies is 2/6 (3/3 by post).

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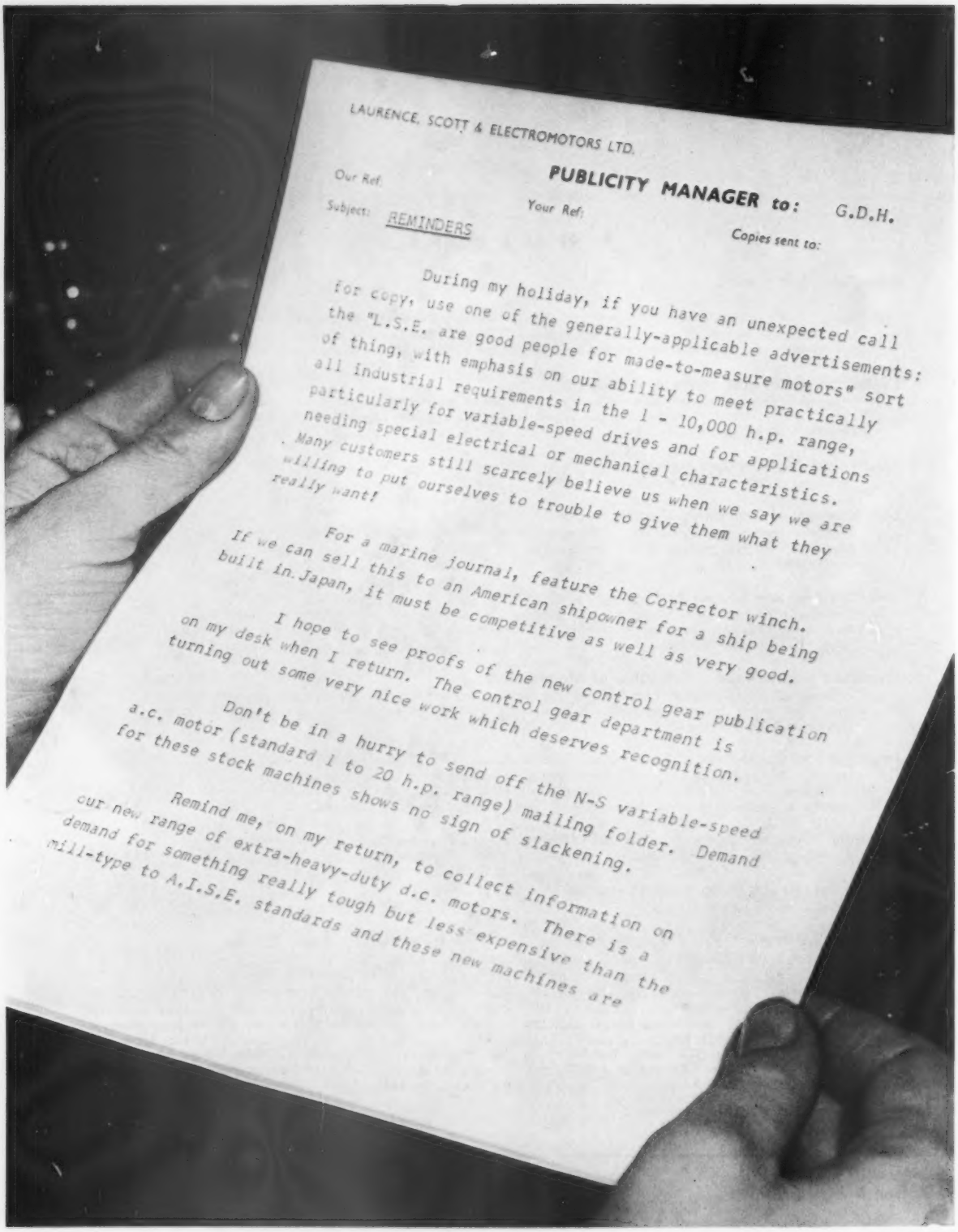
Contributions. The Editor invites original contributions on mechanical subjects. Broadly the aspects covered are the design, materials, manufacture, process, management and maintenance of engineering and industrial plant and machinery. Sketches should be in black ink if possible but the lettering may be left in pencil. Photographs are welcome and so are short notes of practical experience. Payment is made for exclusive contributions. Communications should be addressed: The Editor, MECHANICAL WORLD, 31 King Street West, Manchester 3.



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Mechanical World —— August 1960

The Acceleration of Calculation

THE development of computers is a new activity engaging the attention of the scientifically and technologically advanced countries. It has taken different lines according to the nature of the incentive; where there has been heavy governmental subsidy it has tended to follow difficult and advanced scientific paths. In Britain the cost of development has been borne by the resources of the firms concerned and consequently most attention has been given to immediate practical utility with a view to selling computers as business propositions. The pace has been rapid and this year's conference of the British Computer Society showed quite clearly that British manufacturers have secured, for the present, a long lead in computers for commerce and industry; and incidentally have conferred considerable advantage on those British enterprises which have applied the instrument in their organizations. This is a development from computers for scientific work, which as British products are equally to the fore in meeting the widest range of current needs of research. Broadly speaking they are capable of any kind of calculation. Still in the scientific field but with special application are such computers as those for controlling the radio telescope at the Nuffield Radio Astronomy Laboratories, and those used to simulate in advance the life histories of atomic power stations. Passing from the scientific to the technological we find the computer applied to the control of mass production, to the investigation of variations in machine design and the automatic calculation of process quantities to enable the exercise of immediate instead of time-lapse control. The approach to commerce is via market research, for which several large concerns now use computers for analysing the vast quantities of data which formerly was done manually and, one suspects, with a good deal of approximation, otherwise the result could hardly have been available in time to be of use. The purely commercial use of the computer is not by any means the least remarkable. To make all the details of wage calculations with all the variations of method of payment applicable in a large factory is no mean task, and yet relatively simple for a computer, for with all the variations there is but one all-embracing pattern and this the computer applies with great speed to every case. This is but one example; all the figure work of accounting processes can be dealt with by computer.

The commercial computer cuts out a lot of labour and substitutes for it, in addition to itself, its operator and programmers and its technician. The last mentioned is there to serve the computer, principally by doing what it says is required, for if any part requires attention the machine indicates the fact, in some cases in typewritten words. The operator controls the feeding-in of data and the form of the output, a duty which requires an interested watchfulness. The programmers are the people with a radically new function. The computer uses a "language" entirely its own and data has to be translated to suit. To do this with a facile regularity requires an organized basis, and this must be determined to start with. The particular circumstances must be investigated and this preliminary work may take two years and cost as much as the computer. Fortunately, as machines go these days, computers are not regarded as being expensive.

There is a further step in course of development. It is not out of the laboratory stage as yet but it is quite certainly coming, and that is automatic programming. The possibilities here are vast and hard to visualize. The speed of a modern computer is well beyond human perception. The effect of automatic programming would be more than additive—much more even than keeping a computer fully employed. It would certainly greatly widen the field from which data could be drawn. In fact, the complete computing apparatus may get pretty near to providing the questions as well as the answers.

LOG SHEET

Yet More Oil

U.K. oil consumption rose by 17·5% in 1959 as compared with the previous year, to reach a total of 36½ million ton (excluding bunkers for ships engaged in the foreign trade), according to final figures issued by Petroleum Information Bureau.

Among the major products, fuel oil consumption (including that for public electricity generation) again showed the greatest increase, being almost a third higher than that for the previous year and reaching 13,811,874 ton. Gas/diesel oil deliveries were up by only 4·6% owing to the declining usage of this product in gasworks.

Altogether, 7,123,569 ton of motor spirit were consumed during the year—7·5% more than in 1958 and demand for premium grades was 16% up. Consumption of motor spirit by commercial users fell by 3%, while the demand for derv (diesel-engined road vehicle) fuel expanded by 11%.

Other increases were: burning oil deliveries by 7% to 1,203,118 ton; aviation fuels 4·1% higher at 1,628,425 ton; and propane and butane by 40·5%. Bitumen consumption reached a record figure of nearly a million ton as a result of increased road-building activity.

Deliveries of all oil products rose from 8,990,686 ton in 1938 to last year's record of 36½ million ton, and compared with a 1938 output of 2,391,722 ton in 1959 oil refinery production reached 39,136,237 ton.

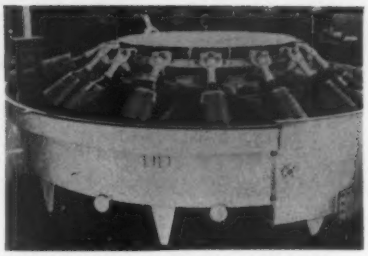
Four-drift Rock Drilling

Engineers of the U.S.S.R. trade delegation in Great Britain recently witnessed field trails at a Derbyshire quarry of a drilling machine of revolutionary design. The first of 15 similar tracked tower drill rigs destined for Russia, it is part of an order already announced worth over £250,000 won by the Holman Group subsidiary, Climax Rock Drill and Engineering Limited, in conjunction with F. Taylor & Sons (Manchester) Limited.

This mobile machine is revolutionary in that four drifters can be operated simultaneously by two operators without fatigue and over long periods and are capable of drilling a rock face from ground level up to 32 ft high and with a horizontal span of 24 ft. It was proved at the trials that the rig was very stable under drilling conditions even when the platform was in the highest position, the hydraulic booms in the highest position, the drifters spread out to their full width of 24 ft and the tracks standing on a gradient of 1 in 10. Four holes can be drilled simultaneously to a depth of 13 ft and Russian requirements will vary from horizontal holes, slightly dipping holes, to holes angled up to 30°. Tungsten carbide tipped 2¼ in. Holbits will be used and drilling speeds of 16 in. per min are expected.

The booms and collapsible tower are hydraulically operated and are remote controlled from panels on the platform above the tower. The tower is mounted on electrically driven tracks which can negotiate rough and uneven ground and a gradient of 1 in 7 was successfully tackled at the recent tests. Crowding rams of 30 in. stroke are provided so that the feed cradle can be pushed up to the rock face and for movement in confined spaces underground the tower can be collapsed to a height of 11 ft. Electric motors of 40 hp and 7½ hp are provided for track drive and hydraulic pump drive respectively and a compressed air supply of approximately 700 cfm is required.

One of the 15 tracked tower drill rigs undergoing field trials in a Derbyshire quarry. Four Holman drifters are shown in action simultaneously



AUTOMATIC GALVANIZING.—Galvanizing of small parts is carried out automatically by this rotary machine made by F. Blasberg of Solingen-Merscheid. The cam-operated plating buckets are mounted on a Roballo ball bearing slewing ring 40 in. dia. and are dipped into different baths during the galvanizing cycle

Mechanized Poultering

With the recent completion of their £300,000 Aldershot factory and the resultant increase in production, the Buxted Chicken Company Limited is one of the largest firms in Europe producing oven-ready chickens. The company operates three stations which produce a total of 200,000 birds each week. The Aldershot factory, believed to be the most modern of its kind in the world, has been planned to allow for considerable expansion, and the floor area, stores and plant rooms are designed accordingly.

The birds are placed on a Johnson-Stephens overhead conveyor, and within seconds are electrically stunned, killed and bled. After plucking and evisceration, body heat is removed in chillers, the birds passing inside a rotating drum which thoroughly immerses them in water which is chilled by the addition of flake ice. This ice is produced adjacent to the equipment by York DER 25F automatic icemakers operated from 10 hp Refrigerant 12 units, and stored in insulated bins. The birds are then packed in polythene bags, weighed, labelled, and placed on tiered trolleys ready for freezing.

Freezing is carried out by air-blast methods in two tunnels each approximately 60 ft long, believed to be the largest of this type. Finned evaporation coils are installed in each tunnel operating on the ammonia pump circulation system, the air being circulated by double inlet fans V-belt driven. Air is delivered to the birds at not higher than minus 40° F. As the loaded trolleys are fed into the tunnel the operator presses a button which starts up a short conveyor and as the trolley moves along it shunts those already in position, maintaining

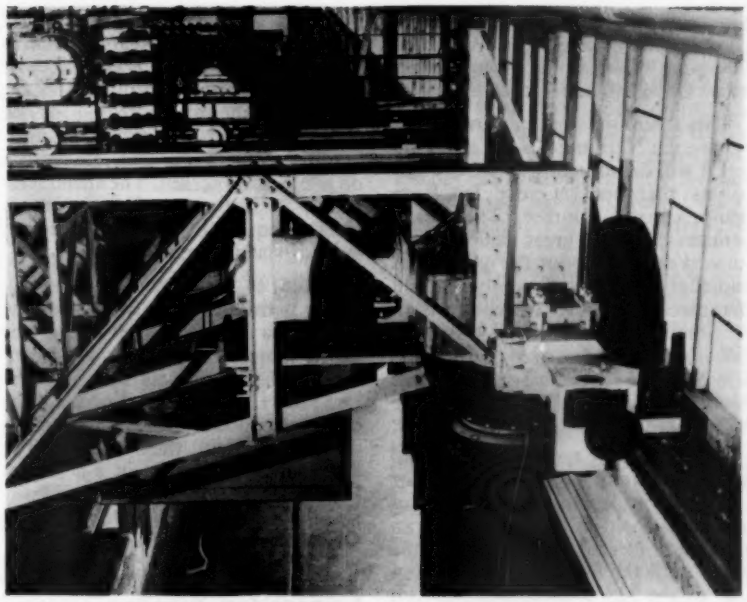
progress. When any trolley reaches the end of the tunnel a trip is automatically operated and a similar conveyor system projects it forward ready for removal of the birds to the cold store. The refrigerating equipment for the tunnels, designed by York Shipley Limited comprises a two stage ammonia compression plant, having separate low and high stage machines providing flexibility for load variations. Low stage compression is produced by three York 15 in. × 10 in. vertical single acting ammonia booster compressors, while two York 9 in. × 9 in. twin cylinder compressors provide high stage compression.

After freezing, the birds are packed in cartons and transferred to a store where they are held for a short time at a temperature of minus 5° F. The plant for this duty comprises two York 5 in. × 5 in. twin cylinder vertical single acting ammonia compressors. Condensers, common to freezing tunnel and cold store duties, comprise a battery of York model EV 126A forced draught evaporative type units mounted over a concrete water cooling tank situated outside the plant rooms. Loading is carried out through a delivery hatch built in the outside wall.

First Rubber-tyred Cranes

Two rubber-tyred, overhead, electric travelling cranes at the Reed Paper Group's Aylesford Paper Mills, near Maidstone, Kent, are believed to be the first in the world. The cranes, which have been in operation for over six months, run on pneumatic tyred wheels which travel on smooth concrete runways, thus dispensing with the traditional gantry rails. With this innovation operational efficiency is improved and impact eliminated so that the cranes do not have to be so heavily constructed; and different methods can be employed in the erection of the buildings in which the cranes operate, thus resulting in a lowering of construction costs.

The intense operation cycle demanded from the cranes, partly because of continually increasing throughput, accentuated the problems generally associated with running steel-wheeled, overhead cranes on gantry rails at high speed when considerable long travelling is involved. Accordingly, Reeds took the first possible opportunity to improve the operational efficiency of the cranes by mounting them on rubber-tyred wheels when this idea was put forward by W. S. Atkins and Partners.



Two rubber-tyred, overhead, electric travelling cranes—believed to be the first in the world—have been in intensive operation for over six months at the Reed Paper Group's Aylesford Paper Mills, near Maidstone, Kent. Pneumatic tyred wheels run on a smooth concrete runway, thus dispensing with the traditional gantry rail

Tests conducted by Strachan and Henshaw Limited, the specialist crane manufacturers, who collaborated with Atkins and Partners, showed that no difficulty in long travel motion was created by a vertical step of 1½ in. and a distortion in the test track equivalent to a lateral displacement of 4 in. of one building column in relation to adjacent columns.

The cranes have a nominal span of 69 ft 6 in. and a lifting capacity of two tons, which may be increased to three tons by the installation of a larger hoist-motor. Each end-carriage is supported by five pneumatic tyred wheels, standard commercial vehicle type tyres (Michelin X 7·00-20), together with two horizontally mounted solid-tyred wheels which bear on the sides of the concrete runways to keep the cranes running in a straight path. Disc brakes are fitted to two of the pneumatic wheels of each end-carriage assembly, and a 7·5 hp electric motor drives one other pneumatic wheel through reduction gearing.

Use of rubber tyres has provided an additional advantage. Although it is intended that each end-carriage be driven by a separate electric motor, in an emergency the crane can be operated with only one motor driving one side of the crane. This would be impossible with a crane having traditional steel wheels.

Before conversion, the original end-carriage of the cranes at Aylesford had steel wheels which ran on rails grouted to the top of the concrete gantry beams. The conversion consisted of fitting redesigned end-carriages and removing the rails, with the result that the rubber-tyred wheels now travel on smooth concrete runways. As a result, the speed of the cranes has been increased from 300 ft to 360 ft per min, and it is possible further to increase the speed to 400 ft per min if desired.

Acceleration to full speed can be accomplished in six seconds and the crane, with its disc brakes, can be brought to a standstill from full speed in 6 ft.

Coal for Economy

A £1¼ million order by the Ford Motor Company for a coal-fired boiler has been secured by Babcock and Wilcox Limited. Before deciding to use coal Ford's made a careful scrutiny of other fuels, including the possibility of producing low pressure steam from atomic reactors. The

coal will be brought by sea from a Durham coalfield to the Ford Motor Company's wharf at Dagenham; 600,000 ton will be required annually.

This decision has naturally delighted the National Coal Board who feel it will demonstrate to other companies that coal is very far from being a back number. The board believes there is a great deal of uninformed opinion about the use of coal and that it is not sufficiently realized that mechanically stoked coal is both economical and smokeless. Mechanical stokers can be used with every size of plant—from a small unit for heating a hall or school to a large industrial unit.

There are four types of mechanical stoker in common use: the chain or travelling grate stoker consisting of an endless belt on which is spread an even layer of coal to travel along the grate until the ash falls off; the coping stoker has a reciprocating ram acting at the base of the fuel hopper and the coal travels forward by the movements of the grate and the feeding of fresh coal; in the underfeed stoker, particularly suitable for smaller boilers, the coal is conveyed into the boiler by a screw feed, propelling the fuel under the static incandescent fire-bed; finally, the sprinkler stoker uses a set of revolving paddle blades to project the fuel continuously and evenly over the surface of the grate. Each of these stokers requires the minimum of supervision and burns coal at optimum efficiency without the emission of smoke.

Infra-red Seeing

A new infra-red system sensitive enough to see moving objects near room temperature solely by means of the invisible heat rays they emit has been developed by scientists of the Westinghouse research laboratories in Pittsburgh, Pennsylvania. Known as the phothermionic image converter, the all-electronic device changes the infra-red radiation emitted by an object into a visible picture on a television screen. The speed with which it responds to infra-red is roughly equal to that of the human eye to visible light.

Lifting of military security restrictions permitted disclosure of the device at a meeting earlier in the year of the American Institute of Electrical Engineers. It was described by Dr. Max Garbuny, head of the team of Westinghouse research scientists that developed the system. The development, the first in a series of such devices, was sponsored mainly by the Wright Air Development Centre of the U.S. Air Force

Computer Service

Earlier this year the Paymaster General, the Rt. Hon. Lord Mills, simultaneously opened the new demonstration centre of International Computers and Tabulators Limited at Hamilton House, Piccadilly, W1 and their new computer centre at Putney Bridge House, SW6. Closed-circuit television enabled Lord Mills to perform the feat.

Hamilton House is devoted entirely to punched card equipment and displays the full I.C.T. range. At Putney Bridge House, a modern six storey building, the company is concentrating its computer specialists to provide an enlarged service to computer users. The accommodation includes machine rooms for three or more computers, three conference rooms with facilities for showing films and visual aids, and rooms for informal discussion. It will also house the applications department and the central programming department. The former determines whether a computer can help in solving a problem and, if it can, will devise a method of fitting the commuter operation into the user's organization. The central programming department translates the problem into machine language. Both departments aim to reduce the customers' preparatory work.

I.C.T. now has 23 manufacturing premises in the United Kingdom as well as research and training establishments and sales office.

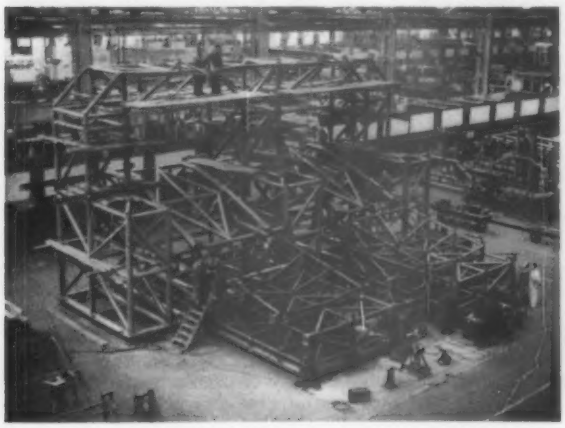
Staff number some 18,600, 3000 of them overseas.

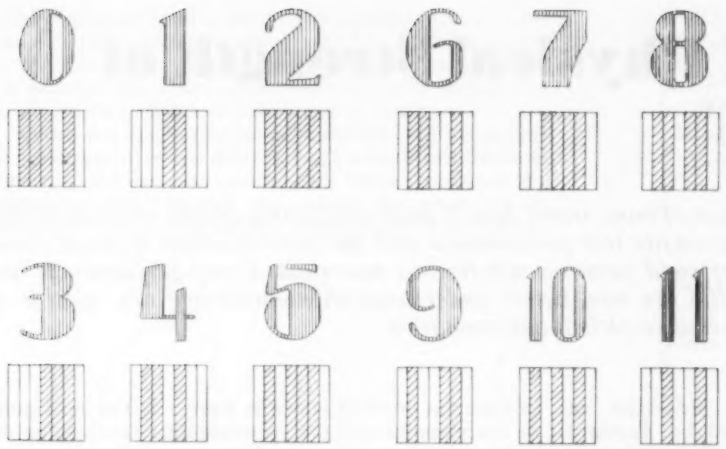
Electronic Figure Reading

In a typical day's voucher clearing in the United Kingdom over two million cheques are sorted for return to about 10,000 branch banks. Manual sorting methods are finding it difficult to keep up with the increasing numbers of cheques being used, so the banking industry is studying the advisability of installing electronic figure reading and sorting equipment.

FRED—E.M.I.'s new Figure Reading Electronic Device has been developed as a numeral reading machine specifically for use with bank cheques and for other similar business purposes. All the data normally found on a cheque—such

JIGS FOR THE BRITANNIC.—At left is the jig for building simultaneously two rear sections of the SC5 Britannic freighter, and at right jigs for tailplane and fin spar. Among the largest ever erected in Britain they are well under construction at the Belfast factory of Short Brothers and Harland Limited. The tube diameters vary from 3 in. to 10¾ in.





as serial number, branch number, customer's identity and amount—can be coded along the bottom edge using the FRED numerals. Cheques, in sizes ranging from 6 in. × 3 in. to 8 in. × 4 in. can be sorted indiscriminately and other special sizes can be handled if required. Punched card cheques, when printed with FRED characters, can be read simultaneously with normal paper cheques. Accurate spacing of the characters along a line, or the precise positioning of any character relative to the leading edge of a cheque in the sorter is not necessary, and normal printing tolerances are sufficient.

A reading machine intended for use in business offices should be very reliable, fast, compact and of low cost. Whilst it is relatively easy to meet these requirements with a bar code reader, since the detection of such a simple "pattern" is a comparatively straightforward problem, it is much more difficult with complex shapes such as conventional Arabic numerals.

This difficulty has been overcome in the FRED system by building a five element bar code into the design of the numerals. The resulting typefaces are visually similar to conventional designs—they are in fact based on an existing fount called Broadway—and are therefore easily recognized by the human eye. Furthermore, the machine is presented with what amounts to a simple 5 unit bar code, which, with magnetic ink printing, leads to very reliable machine recognition. The FRED numerals and inter-block symbols are shown in the accompanying illustration, the corresponding bar code being drawn under each numeral for comparison purposes.

Consider, for example, the numeral 'zero'. Referring to the bar code beneath this numeral, and reading from right to left the columns are black, white, black, black, black. If the numeral is also imagined to be divided into 5 equal vertical columns, it is clear that these too (reading in the same direction) are: (1) mainly black, (2) mainly white, (3) mainly black, (4) mainly black, (5) mainly black. If a "mainly black" column is represented by 1 and a "mainly white" column by 0, the code for zero is 10111, as for the bar code. Each numeral is coded in this way.

As the first digit in each code is always 1—the right-hand column of each character is always black—this form of the code gives four variable digits, with 16 possible combinations.

Money for Exports

Provisional figures for 1959/60 issued by the Exports Credits Guarantee Department once again show a satisfactory trading year. The value of insured exports was £671 million compared with £549 million for the previous year; commitments were £544 million (an increase of £50 million); and there was a correspondingly increased cumulative reserve. The revenue balance was well up because of lower claims and a well-maintained level of recoveries. Premium income was much the same as in the previous year.

Three innovations during the year showed encouraging results. The offer of a 5% rebate of premium to established policyholders who renewed their whole turnover policies for three years instead of one was accepted by 90% of those to whom it was made. A new Constructional Works Guarantee resulted in the issue of policies to the value of £24 million and more being negotiated. Finally a system whereby branch offices could agree figures of cover on individual buyers was well received.

A number of new developments come into operation during the current year. Hitherto the whole turnover (and selected markets) type of cover for engineering goods was limited to business done on up to three years' credit; now the period can be extended which will particularly benefit manufacturers of certain engineering goods sold on credit longer than three years.

Policies for the external trade of United Kingdom Merchants have been completely redrafted; The waiting period for admission of claims has been cut from six months to four months and the permissible period of preshipment cover under a "contracts" policy has been increased from three months to six months. Other developments include standard policies for services cover, the introduction of stock cover for external trade, and lower rates for processing cover.

Scots Electrical Jubilee

The Scottish Centre of the Institution of Electrical Engineers has been celebrating the diamond jubilee of its foundation. In 1899 a group of Scottish engineers meeting in Glasgow petitioned the I.E.E. in London to approve a local centre and on December 14 of that year official approval was granted. Lord Kelvin became the centre's first chairman and the great man was a prominent figure in the centre's early years. Other notable men like Henry A. Mavor, Angus Maclean and Francis G. Baily were chairmen.

During its sixty years of valuable service to the electrical engineering profession the Scottish Centre has grown in both numbers and prestige. Membership is now just over 2000. The work of the centre covers lectures, exhibitions, educational visits, sections for graduates and students, and social activities. This year an electronics and measurement group has been formed. The present chairman is J. A. Aked, M.B.E.

Evaluation of Physical Strength of Materials

Evaluation of basic stress data is dealt with in this article which describes standard tensile test performance and the determination of proof stress in lieu of yield point on non-ferrous materials. Creep performance and fatigue life are now better understood phenomena and are capable of analysis and empirical determination

BASIC physical and mechanical properties of engineering materials are evaluated on standard test pieces and standard testing machines, the significance of which may be overlooked by those whose job it is to apply such data from time to time rather than to deal with such matters as day to day routine.

The most common mechanical strength figures are related to static stresses produced by dead loads, tensile strength being the most common of these. These data are evaluated on standard test specimens in tensile testing machines, the accuracy of which is usually rated to within plus or minus 0·2%, although this can deteriorate on older machines. Test technique and dimensions for the test specimen are detailed in British Standard B.S. 18.

Tensile strength is evaluated in terms of stress against strain, which is why the figure achieved is correctly quoted as tensile stress (or maximum tensile stress), rather than maximum tensile strength. This is actually not a true stress figure since it is evaluated on the original cross sectional area, irrespective of any reduction in cross section following strain. Strain is the deformation produced by stress and in tension or compression testing is expressed as the change in length relative to the original length of the test specimen. This remains valid for design work since strength figures are invariably calculated on the original (unstrained) sizes of materials involved.

A typical stress-strain curve for a metal shows a proportionate increase in strain with increasing stress, the latter determined as the applied load divided by the original area of the test piece. With increasing stress a point is reached where the stress-strain relationship is no longer linear and strain starts to increase more rapidly and is no longer perfectly elastic.

This region is difficult to plot accurately, but at some slightly higher value of stress, marked elongation of the test piece will start to occur without any further increase in load the onset of which is known as the yield point of the material and the corresponding stress value the yield stress—see Fig. 1. This is usually reasonably easy to determine with ferrous metals, the criterion being that an increase in length of at least 0·5% of the original length is produced at this stage. Further loading will then produce a rapid increase in strain, up to the point where the test piece develops a 'waist' and subsequently fractures at this point.

Because of the considerable reduction in cross section when the 'waist' develops, the actual breaking stress is less than the maximum or ultimate stress developed on the test piece. In other words less load is required after 'waisting' has developed to produce a fracture and breaking stress or the true load to break has little practical value. On the other hand, all stresses beyond the yield point are subjecting the material to strain from which it cannot effect permanent recovery. Maximum permissible stress, therefore, would normally be rated well within the limit of proportionality—i.e. below the yield stress figure.

A number of materials—e.g. aluminium and light alloys and most non-ferrous alloys do not exhibit a definite yield point. In the case of nickel-chromium steel, for example, the limit of proportionality extends into a fairly smooth curve, whilst certain aluminium alloys progress beyond the limit of proportionality in a number of 'steps', equivalent to a number of different yield points—see Fig. 2.

The criterion adopted in such cases is proof stress, defined as the minimum stress required to produce a non-proportional elongation of a specified percentage of the original length. The non-proportional elongation taken is usually 0·1% and the proof stress calculated on the basis of the load required to produce no more than this when applied for fifteen seconds and then removed. This proof stress figure is equivalent to plotting a line from the appropriate strain value (0·1%) parallel to the

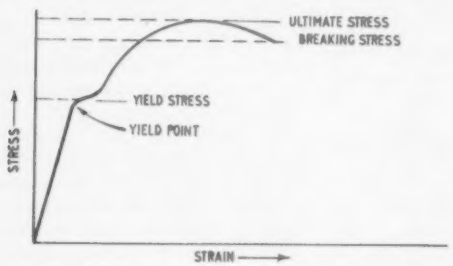


Fig. 1.—Typical stress-strain curve for a ferrous metal

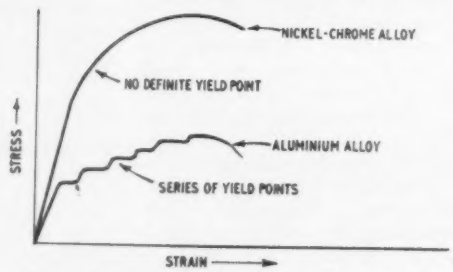


Fig. 2.—Typical stress-strain curve for non-ferrous metals

limit of proportionality to cut the complete stress-strain curve at the proof stress value—see Fig. 3. Other values of proof stress may be specified in certain circumstances, i.e. proof stress figures appropriate to loads required to produce other values of permanent extension.

Under live load conditions, materials will be subject to additional dynamic stresses. Impact loads or additional tensile, torsional or compressive loads produced by unbalance and vibration in rotating machines can be evaluated from first principles, although this is not always

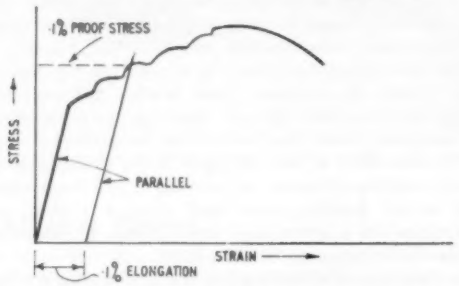


Fig. 3.—Definition of proof stress, relative to stress-strain curve

convenient or easy. Even static loading under certain conditions (usually high service temperatures) can produce a varying strain through the phenomenon known as 'creep'.

In the latter case, behaviour can be evaluated from test pieces by plotting the strain-time curve, the whole of the test being conducted under controlled conditions at the appropriate temperature.

The standard form of the strain-time curve shown in Fig. 4 is typical as a generalization and shows that there is no such value as a 'limiting creep stress' as creep is generally progressive throughout at high ambient temperatures and ultimately begins to accelerate. No general standard is available as to maximum permissible stress under creep conditions but a figure which appears to have been adopted is that stress corresponding to an increase in strain or creep rate of not more than one part in one million per 1,000 hr.

Fatigue strength, where the material is subjected to alternating or fluctuating loads, is based on the stress-number of cycles of loading (S/N) curve and considerable advances have been made during recent years on the

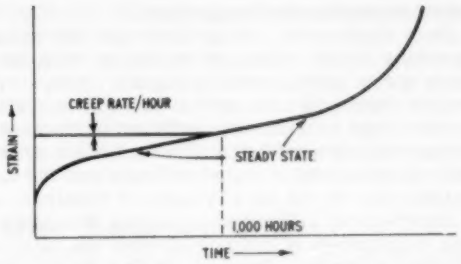


Fig. 4.—Typical 'creep' curve at elevated temperatures

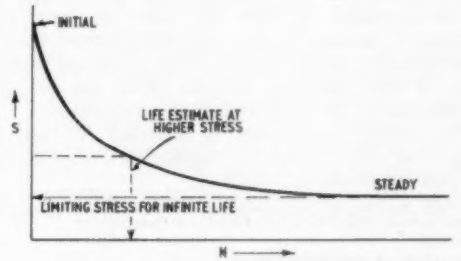


Fig. 5.—Generalized form of fatigue curve, evaluating stress against number of cycles of fluctuating load

question of developing suitable machines for evaluation of such curves. Mechanical testers have been supplemented by ultrasonic testers which enable a high cycling rate to be achieved, thus cutting down on the time consumed by such tests. The general trend of S/N curves (although this is not invariably so) is for the limiting stress to assume a constant value at some particular value of N—see Fig. 5. Alternatively the ultimate life at some higher figure of stress may be estimated from its intersection with the S/N curve.

The older—one could almost say 'traditional'—types of dynamic test machines are still used for impact tests, although such values obtained are of little direct value for design use. Their main application is as a measure of brittleness as it might be affected by changes in physical form, heat-treatment or processing, etc.

Somewhat similar comment can be applied to hardness testing, although in this case the data is more directly related to specific performance and of universal value.

Mechanical Engineering Research

Notes on some current investigations

Extrusion of brittle materials

A promising new method of extruding brittle materials is being developed at the National Engineering Laboratory. The billet is immersed in a fluid at high pressure, and the extrusion is carried out inside a high-pressure container.

If a material like magnesium or bismuth is extruded in the ordinary way at room temperature with only a fairly small reduction in area, the surface of the product may be so badly cracked that it is useless. Since materials behave in a more ductile fashion when surrounded by a fluid at high pressure, it seemed likely that better extrusions might be produced in this way.

Rods and tubes with an acceptable surface finish have been obtained with bismuth and magnesium at fluid pressures of a few tons per square inch. The work so far has been carried out on a small scale, using billets of $\frac{3}{8}$ in. dia.

Further work is in progress with 60/40 brass but fluid pressures of more than 50 ton per sq in. are needed with this material. It is hoped to develop the techniques to the stage where high-pressure forming can be used as an industrial process for metals which cannot be worked by normal methods. One possible use would be the manufacture of beryllium cans for nuclear reactors—beryllium is a notoriously difficult and dangerous material to work using conventional processes.

Certain aspects of pressurized extrusion are covered by British Patent Applications Nos. 17603/58 and 6626/59.

MERL Plasticity Report No. 147. (The behaviour of metals under hydrostatic pressure. III—Extrusion under pressure, by H. Ll. D. Pugh and D. Green.)

Accurate measurement of temperature

Robust equipment is being developed for measuring temperature under industrial conditions with an error of only a few milli-degrees centigrade. A new type of resistance thermometer is used: it contains two elements, one with a high temperature coefficient of resistance and the other with a low coefficient. The former is a copper wire wound on an insulated copper cylinder and the latter is minalpha wire wound on a cylinder of minalpha; in this way the effects of differential expansion are reduced.

The temperature is determined from the ratio of the resistances of the two elements, which form two arms of a bridge (either a.c. or d.c.). Owing to the use of the twin elements in the thermometer the bridge circuit can be arranged so that the effect of long leads is eliminated. An a.c. bridge with transformer ratio arms is particularly suitable since these arms can readily be made of high accuracy and the ratios are not affected by vibration or by variations in air temperature.

The existing equipment is intended for use in the range 0 to 100° C, but the method can also be applied to other temperature ranges.

NEL Fluids Note No. 82. (A resistance thermometer and bridge of millidegree accuracy for field use, by W. H. P. Leslie and J. J. Hunter.)

Inspection of precision gears

A new instrument has been developed for checking the accuracy of spur gears up to 4½ in. dia. It is suitable for the industrial inspection of gears used in instruments and mechanisms where accurate indexing is important; for example, those used in dividing mechanisms, in radar and fire-control equipment.

The instrument is a mesh tester in which the usual master gear has been replaced by a master rack (which is mounted on a floating carriage). A reference straight edge, parallel to the rack, is fixed to the base of the instrument. A second carriage carries the test gear and a disc of the same diameter as the pitch-circle of the gear; the disc and gear are mounted concentrically on a mandrel. The carriage is driven parallel to the rack and straight edge by a lead screw and electric motor.

When inspecting gears which have to transmit uniform angular rotation, it is necessary to record errors while the gear teeth are meshing on only one flank. As the disc rolls along the straight edge, the test gear makes single-flank contact with the master rack; errors in the gear cause the rack carriage to move to and fro in the direction of traverse of the gear. This movement is detected with an inductive gauge, amplified, and recorded on a paper chart.

The record shows the overall effect of the errors on the uniformity of motion transmitted. Individual errors, such as cumulative pitch, adjacent pitch, and eccentricity, can be assessed from the chart record.

The instrument can also be used for conventional dual-flank tests.

The Laboratory is willing to make working drawings of the instrument available to engineering firms and other organizations. A fee will normally be charged.

NEL Report Mech/Met 128. (Instrument for the measurement of gear transmission errors, by C. Timms and O. R. Hunter.)

Air-lubricated bearings

In the commonest type of air bearing, compressed air is supplied through orifices to provide a cushion of air between the parts in relative motion. Compared with conventional bearings air bearings are relatively easy to manufacture, they are practically frictionless, and they do not wear.

Because of these advantages, they have been used by NEL in several types of precision measuring instrument. One example is a roundness measuring machine in which an air-lubricated journal bearing provides a precision axis of rotation for the measuring head. Movement of this axis is within a circle of 10 microinch dia, even though the journal and bush have not been manufactured with particularly high accuracy.

Another example is a flat air bearing for a saddle which has to move accurately in a straight line along a precision girder without sticking. The saddle on air bearings was found to yaw, pitch and roll considerably less than when mounted on precision ball bearings. The saddle and girder form part of a machine for measuring pitch errors on precision lead screws automatically.

Experiments with flat air bearings have shown that the maximum static load which can be carried is approximately one-third of the product of the bearing area and the air supply-pressure. Formulae have been obtained from which bearing area and size of orifice can be determined for a given load and air gap; bearing stiffness and air flow may also be calculated.

An entirely different type is the self-acting air bearing where air is drawn in by rotation of the shaft, and a load-carrying air film is generated by hydrodynamic action. Because air has low viscosity, the loads which can be carried are small unless the shaft is running at high speed. With a conventional bearing clearance, the maximum load which can be carried by a 1-in. dia bearing running in the speed range 30,000 to 50,000 rpm is about 1 lb per sq in. of bearing area for every 1000 rpm. The characteristics of this type of air bearing are not yet fully understood, and investigations have been carried out to help in providing data for their design.

NEL Report Mech/Met 132. (Air bearings—research and applications at NEL, by M. Graneek and J. Kerr.)

Pressures losses in oil fittings

Thirteen manufacturers of valves, positive-displacement flowmeters and other fittings used in oil hydraulic circuits are now able to supply designers with details of the pressure losses in their standard components. These data have been obtained by manufacturers' staff working on the special oil-fittings rig at NEL.

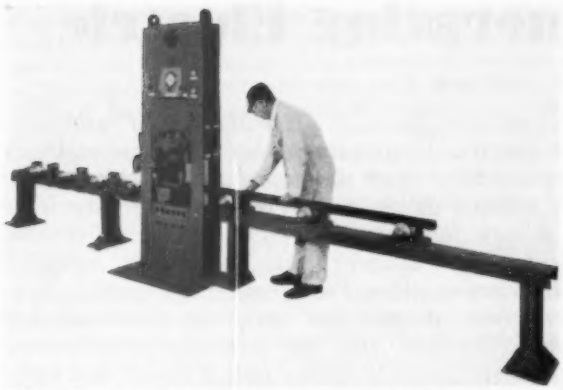
Many oil-hydraulic circuits consist of several individual units connected by pipe-work to various valves, filters and other fittings, each of which will produce some loss of pressure head. If the designer cannot obtain data on the pressure losses in the fittings, the circuit may be needlessly large and expensive or, perhaps, too small to do its job properly.

Trouble in hydraulic circuits often arises from lack of appreciation of pressure losses in fittings. For example, a user may take special care to select an expensive pump of high efficiency and then connect various fittings to it, on the suction side, in which the losses are so great that the pump cannot work at maximum efficiency, is noisy, and has its life shortened by cavitation damage.

There is now considerable demand from designers for data on the flow characteristics of commercial fittings for oil-hydraulic circuits so that the most economical circuit for a given duty can be designed. A rig has therefore been provided at NEL for manufacturers to measure the pressure losses in their own fittings. Hydraulic oil of either of two viscosities can be pumped through it at flow rates up to 250 gallons per minute under pressures up to 800 lb per sq in.

The design of fluid power circuits, NEL.

The various reports mentioned above are available from the National Engineering Laboratory, East Kilbride, Glasgow.



This machine will make impressions on bars deep enough to be filled with contrasting paint

Marking Bars

A new type of roll marking machine especially adapted for the marking of trade marks on black angle, channel and bar materials at intervals has been designed by Edward Pryor and Son Limited, Broom Street, Sheffield 10, as a solution to the problems involved in procuring impressions deep enough to be filled with a paint contrasting with the normal painted colour of a long part.

The machine is air operated with electrical controls. The main frames are flame cut from ½ in. boiler plate and a table resting on the bottom edges of the main opening supports the work during the marking operation. Pressure is applied by means of twin cylinders with a ball bearing guide to a crosshead on which the pistons apply their thrust. On this crosshead is mounted a ball bearing slide and the carriage of this is pushed backwards and forwards by a horizontal air cylinder. This carriage conveys a roller die to and fro along the work, the die being mounted on ball bearings and geared to a stationary rack to ensure the characters being at all times registered correctly with the to and fro movement of the die. Conveyors are provided on both sides of the machine to carry the work in and out. On the out-going side a number of microswitches are arranged which are operated in turn by material passing over them, and these comprise part of the control system of the machine. The electrical instruments and air valves are mounted upon two stout instrument panels and enclosed behind with detachable sheet steel covers. Two signal lights are provided to indicate to the operator how the machine is working.

Multiplane Diffractometer

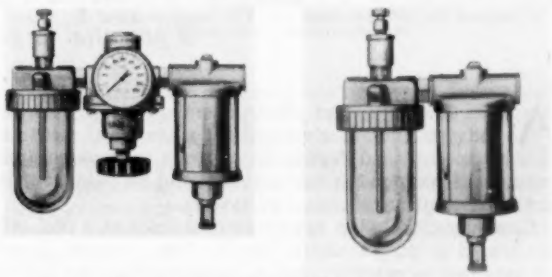
A new multiplane diffractometer for fully automatic or manual operation, based on a design currently in use at the Atomic Energy Research Establishment at Harwell, has been produced by Seton Creaghe Engineering Limited, of Park Royal, London. Apart from its use in the nucleonics field it is of value in the chemical, mining, minerology, semi-conductors, welding and metal industries, and in universities where research in crystal structure analysis is constantly being carried out.

The diffractometer is an X-ray instrument designed to use the Shulz method of determining the preferred orientation of crystals. This method enables the intensities of reflections to be related, without correction, to the number of crystals reflecting. By this method the instrument can be used to examine the crystal structure of a specimen in any plane by the simple but precise adjustment of the goniometer ring. The setting up is rapid and no re-adjustments are needed when the plane of examination is altered. Seven simple adjustments are all that are needed to prepare it for use. The Seton Creaghe instrument incorporates goniometric and scanning movements fulfilling the requirements of rapid operation and extreme accuracy. Its weight is approximately 75 lb.

Airline Lubrication

The Controlube unit introduced by B.E.N. Patents of High Wycombe aims to ensure clean, controlled airline lubrication and so reduce maintenance and prolong the service life of air powered motors, tools, cylinders, valves, etc.

There are three components. No. 238 moisture separator for the removal of condensed water and other impurities is fitted with replacable filter and supplied complete with drain cock. No. 233R pressure reducing valve complete with pressure gauge has a special relieving feature which automatically increases or decreases pressure on the outlet side to the pre-set figure on the dial of the pressure gauge. The remaining component is No. 276, a replaceable bowl lubricator which provides



The Controlube in major and minor versions for the lubrication of air lines

lubrication for all types of pneumatic tools by means of a regulated airborne oil fog. The oil flow is automatic, the rate of feed clearly visible through the sight glass, and the oil feed is easily and accurately adjusted by the screw at the top of the lubricator. Refilling can be done without closing air flow.

Microhardness Tester

The Model LL Tukon semi-automatic microhardness tester manufactured by the Wilson Mechanical Instrument Division, American Chain and Cable Company Inc., U.S.A. and available in this country from George H. Alexander Machinery Limited, 82-84 Coleshill Street, Birmingham 4, has a range of indentation loads of from 25 to 1000 gram and a vertical capacity of 2½ in.

The instrument is equipped with a rigidly mounted, high powered, Bausch and Lomb microscope with 14X par-focalled dry objective to permit rapid scanning of the specimen surface to select desired location of test. In addition, its calibrated 40X par-focalled dry objective is used for rapid measurement of the length of hardness indentations directly in microns.

The tester utilizes both the Knoop and 136° diamond pyramid indenter, providing accurate measurement of the indention in a selected area. It employs a dead-weight system of load application in increments of 25, 50, 100, rising by 100's to 1000 gram depending on the size of specimen and the problem being studied.

New Methods of Generating Electric Power

It has been announced recently by Dr. S. N. Herwald, Vice-President—Research, Westinghouse Electric Corporation, that four new methods of generating electric power have been developed to the state where they appear to hold real promise as power sources for the future. This work is being pursued in new laboratories which John K. Hodnetle, Executive Vice-President, says doubles the company's research facilities. Dr. J. A. Hutcheson, Vice-President—Engineering, summarizes the four new methods as the fuel cell, the thermoelectric generator, the thermionic generator, and the magnetohydrodynamic generator. These operate at successively higher temperatures and raise entirely new problems in materials. The possible rewards are great however—high efficiency, low capital costs, and new possibilities in power generation, storage and use. In the following articles members of the Westinghouse research team explain the preliminary stages of the work

High Temperature Fuel Cells

A potential large scale power source

By R. RUKA

A FUEL cell is an electrochemical device which converts the "free energy" of a chemical reaction directly to electrical energy. In contrast to conventional batteries it consumes a low cost fuel and an oxidant that are continuously fed into the system.

Consider closely the operating principles of a fuel cell illustrated in diagrammatic form in Fig. 1, which shows an oxygen concentration cell. It consists of an electrolyte which conducts an electric charge in the form of oxygen ions but is an insulator to electrons. The electrolyte is sandwiched between two electrodes. A voltage is created across the electrode-electrolyte sandwich when the oxygen is at different concentrations at the two electrodes.

In operation an oxygen molecule moves through the porous cathode to the junction with the electrolyte where it picks up four electrons, forming separate oxygen ions. These migrate into the electrolyte and leave a positive charge on the cathode. The ions move through the electrolyte to the porous anode where they release their electrons and combine again to form an oxygen molecule. The anode receiving the released electrons becomes negatively charged. The oxygen continues on into the chamber where it combines with a fuel or is exhausted from the system. If the two electrodes are connected to a load in an external circuit, a current will flow through the load. As long as there exists at the anode a vacuum or a fuel to react with the oxygen, there is a difference in oxygen concentration between the two electrodes, and a current will continue to flow in the circuit.

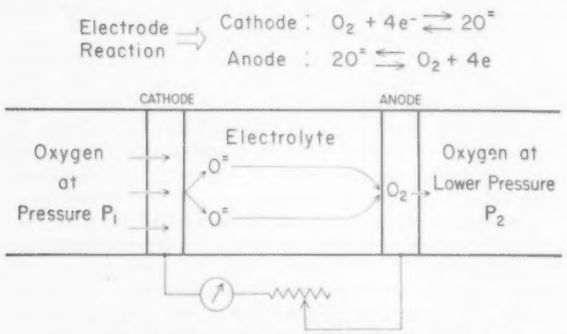


Fig. 1.—Principle of operation of the oxygen concentration fuel cell

Most fuel cells involve more complicated electrode reactions and are more restricted in the fuels they can use. For example, consider the cells listed in Table 1. These are representative of some of the many different fuel cells being developed in laboratories throughout the world today. As the table shows, they vary in the nature of the cell reaction, the electrolyte, the temperature of operation and the direct or indirect use of the cell reactants. Note that all fuel cells operating below 250° C can only use hydrogen or other special fuels. In addition, all are subject to critical catalyst problems since a catalyst is required at the electrodes to accelerate the electrode reactions.

The low temperature cells use either aqueous or ion exchange membrane electrolytes and may be pressurized for better efficiencies. Hydrogen-oxygen cells have the best operating characteristics of all these low temperature cells at present. However, hydrogen is a high-cost fuel.

Table I.—COMPARISON OF FUEL CELLS UNDER DEVELOPMENT

Fuel	Electrolyte	Operating Temp.	Estimated KW/ft³ (cell only)
Hydrogen and oxygen	Aqueous alkaline 50 atm	200–240° C	2–4
Hydrogen and oxygen	Solid ion exchange membrane 1 atm	Ambient to 50°C	3–1·5
Hydrogen and air	Aqueous alkaline 1–5 atm	50–80°C	0·2–1
Hydrogen and air Carbonaceous materials and air	Aqueous chemical intermediates (redox) 1 atm	Ambient to 80°C	0·2–2
Carbonaceous gases	Molten salt 1 atm	500–850° C	1–4

One possibility of improving the economics of present fuel cells is to find a cheaper source of hydrogen. This can be done by improvements in methods of production of hydrogen by reaction of water with fossil fuels or perhaps photolytic dissociation of water using solar energy. An alternative solution is to design fuel cells to use the cheapest available fuels, such as natural gas and coal. This could conceivably make the fuel cell economical for production of electric power in the thousands-of-kilowatts range.

One of the approaches to the use of the low cost fossil fuels in fuel cells involves the use of cells operating at high temperatures. To date, most research devices of this type have used molten salt electrolytes but the use of solid electrolytes is also a possibility. The electrode reactions of fuels such as coal or natural gas can occur much faster at high temperatures, and this important advantage gives cells operating over 500° C better long range potential as cheap power sources.

However, this high operating temperature introduces some severe requirements for other components in the system, especially the electrolyte and electrodes. Cell components must be of low cost, highly resistant to corrosion for sustained periods of time at high temperatures and still retain useful conductivity properties. Materials research is being conducted to produce and investigate physical and chemical properties of fused salts, special ceramics and metal alloys to satisfy these critical high temperature requirements. Fuel processing must also be studied to obtain maximum efficiency and to prevent undesirable side reactions such as carbon deposition at fuel inlets.

A laboratory demonstration high temperature fuel cell has been constructed to demonstrate the concentration cell principle described earlier (Fig. 2). The device operates at temperatures above 800° C. Oxygen is continuously fed into the system at one electrode (the cathode) and the fuel, carbon or a carbonaceous gas is present in the other electrode (anode) chamber. The fuel reduces the effective oxygen concentration at the anode creating a voltage across the electrode-electrolyte sandwich. Current is drawn from this system by connecting an electrical load between the two electrodes.

In any experimental unit such as this the size of the furnace and containers clearly overshadows the fuel cell itself, but it is expected that the furnace can be made a negligible part of a high temperature fuel cell system. This could be done by substituting for the single electrode electrolyte sandwich a whole series of closely stacked plates that can raise the power output considerably. In such a large, high temperature fuel cell, the heat generated by the cell while using low cost fuels, would itself be sufficient to maintain operating temperature. Thus, heat would only need to be added by a preheater at the beginning of the operation. Since its efficiency would be nearly independent of size over a few kilowatts of power output such a high temperature fuel cell might be built as a small mobile unit or as a large central station power source, that would operate economically on today's cheapest available fuels.

The unique characteristics of the fuel cell offer many advantages for electric power generation. For example, a fuel cell system contains no moving parts, and can operate silently. Efficiency is independent of the size of the cell over a wide range of power output as contrasted with steam-turbine generators which have lower efficiency at lower ratings. They are low voltage, direct current devices, which makes them particularly adaptable

Fig. 2.—A laboratory model of a high temperature fuel cell developed at the Westinghouse research laboratories

for economical use in the electrochemical industries. The most interesting property of a fuel cell is that it does not operate on a heat cycle which limits the efficiency of steam-turbine generators and other heat engines. Thus, a high temperature fuel cell system should theoretically be able to produce over *twice* as much useful energy from fossil fuels as today's most efficient steam-turbine generators.

So that it can be compared directly to heat engines, the efficiency of fuel cells is usually defined as the ratio of electrical energy output to heat of combustion of the fuel. On this basis, fuel cells can theoretically operate at efficiencies as high as 70 to 90%, compared with a maximum 42% for today's most modern central station plants.

This is not the complete story unfortunately, since efficiency is also a function of the load on the system. At higher loads efficiency decreases. We must reach an economical compromise where efficiency and capital cost as affected by size and weight of the cell are optimized. An ideal fuel cell would use cheap fuels, be made of economical materials of construction, operate at high efficiency, with high power output per unit volume and weight of cell.

On the basis of estimated power per unit volume at 50 to 80% efficiency and present trends in fuel costs, it appears that the high temperature cells might become competitive with conventional large scale power sources in ten to twenty years, assuming that the critical research problems can be solved. In the meantime, the low temperature cells below 250° C should find special purpose applications where capital and fuel costs are not of primary importance.

For economical large scale power generation, fuel cells that use cheap fuels such as coal or natural gas must be developed. To use such fuels, cells operating at temperatures of 500° C and above appear to have the most promising potential.

Further articles will deal with thermoelectricity, thermionic and magneto-hydrodynamic generators, and current conversion.

Standard Vice and Special Jaw Design

Machine vices are generally regarded as being the maids of all work in the average machine shop and they vie with the four jaw chuck as being the most abused piece of equipment. However, care in use is essential when special jaws are installed because though it is possible to overcome wear in the slides of a standard vice at the expense of some lost time, the specialized type of vice jaw must rely to a great extent on accuracy to achieve reliable location and efficient clamping. The ideas presented here are but a few which can be fitted into the restricted space available to a vice

By JOHN WALLER

HOLDING components in a vice, whether the components are merely square blocks of material or even of complicated outline, does not initially appear difficult, but there are many pitfalls leading to inaccuracy during machining, and there are comparatively few kinds of tooling where so much depends on the skill and attention of an operator to secure a satisfactory work. Again, few pieces of equipment suffer such abuse as the average machine vice, and this introduces slackness in the slides which guide the moving jaw; a factor which is well known in the workshop as being perhaps the chief cause of poor quality in the machining of many details.

Fig. 1 illustrates a typical vice where the moving jaw is arranged to slide by turning a screw, and though the latter is usually of substantial proportions it does not prevent the sliding member from lifting as the jaws contact the article inserted between them. A slight degree of wear is enough to cause the moving jaw to lift, and the practice of introducing a circular bar of material between the clamping jaw and workpiece is employed as a means of overcoming the tilt; the line contact created by a bar is preferable to the wide flat surface of a jaw, and this method is standard practice in tool rooms and other workshops where square and rectangular material is utilized. Generally with this class of equipment the cutting pressure is taken by the moving jaw.

The tendency for a moving jaw to lift is due to the pushing action imparted by the clamping screw, and it has been established that if this movement is reversed and the moving jaw is pulled toward the fixed member, the lifting tendency is reversed and the sliding detail will move in a downwards direction. A design in this category is depicted at Fig. 2, and the screw is arranged to pull the channel shaped moving jaw toward the fixed jaw; the latter on this occasion bridges the slide and the thrust is taken against the base through which the clamping screw passes.

Another design which uses the principle of pulling the moving jaw is seen at Fig. 3, but the screw is this time replaced by a cam which exerts the necessary degree of holding pressure against a bridge piece spanning the moving slide. This cam member is interesting because at the completion of an operation, the handle is loosened and a continued movement causes the heel to meet the bridge seen at the left of the vice to impart a quick movement to the slide and make it open without the need of further hand pressure. This type of machine vice is ideally suitable for the production of small mass produced components where an operator can move between two or three machines; each performing a milling process on what is perhaps an elaborate profile.

Despite the many different commercial vices manufactured for use on milling, shaping, planing or drilling machines, they all more or less employ variations of this design theme, and they are arranged to accommodate specially designed jaws in addition to the hardened pieces used for clamping rough sections of bar material, castings and forgings. However, before discussing the special type of jaw, a few sketches will be discussed to illustrate how tilting of a component is overcome when the vice is used as standard workshop equipment for the machining of the host of details which merely require a flat surface from which to locate subsequent operations.

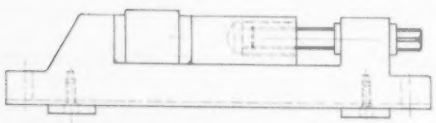


Fig. 1.—A type of vice where the cutting pressure is taken by the moving jaw but which does not present the ideal conditions for accurate machining because of the tendency of the clamping member to lift

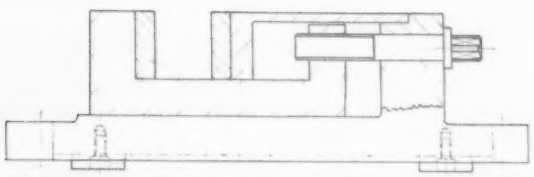
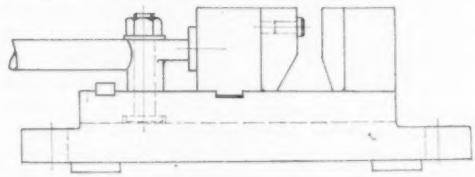


Fig. 2.—This design utilizes the principle of pulling the component toward the fixed jaw and so tending to impart a downward movement to the component



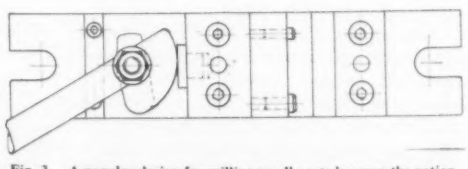


Fig. 3.—A popular design for milling small parts because the action of the cam handle gives fast opening and closing, thereby reducing operation costs

Fig. 4 depicts a rectangular section of bar set upon parallel strips with the top surface just protruding above the hardened jaws, and on this occasion the moving member is shown exaggerated in order to portray the line contact at the bottom of a block which is the only holding means available for what is generally a heavy cut. Such a condition is dangerous and often results in the part being pulled from the jaws immediately the cutters contact the workpiece, or in the piece being milled inaccurately due to the jaws lifting the block from the flat surface of the parallel strips.

The practice of using serrated jaws of the type depicted at Fig. 5 will overcome this tendency as a wedging action is secured which forces the component downwards and squarely against the flat face of a fixed jaw, and the usual raising of a moving jaw does not then create errors as the wedge performs the duties of a compensating piece and so the component is persuaded to seat correctly on the raising block placed underneath.

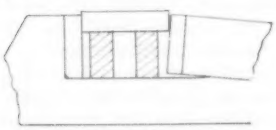


Fig. 4.—This sketch illustrates the comparatively poor clamping obtained when the moving jaw tilts. For thin details there is a risk they will be pulled from the jaws as the cutter makes contact

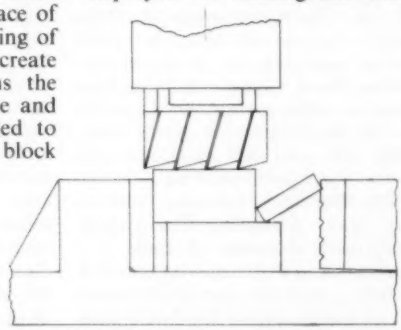


Fig. 5.—The use of a serrated jaw as shown here, gives an opportunity of using a clamping strip set angularly against the workpiece which pushes the detail down on the raising block

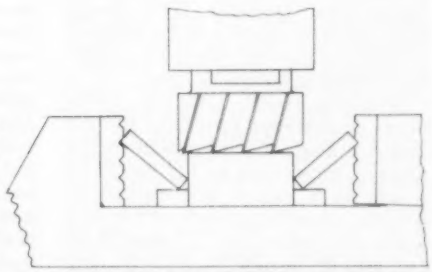


Fig. 6.—For a low setting in the vice a dual arrangement of the clamping strip is used, and this again gives effective tightening action on the component

An elaboration of this idea is portrayed at Fig. 6 where on this occasion two wedges are used, and this ensures a lower setting in the vice. Design restrictions relating to the component sometimes make such a procedure necessary and the pressure imparted by the above-mentioned details are sufficient to hold a workpiece against really heavy cuts. However, such a practice does not produce a face parallel with an edge already machined as the rough hardened jaws of the type fitted for this setting are seldom accurate, and the operation is restricted to milling a flat surface as shown by this drawing.

Compensating jaws for rough components

The machining of any forging or casting using vice jaws as a holding medium, demands the application of a compensating device as a means of overcoming discrepancies in the various details, and similar items are also useful when angular work is attempted on bar material.

Fig. 7 illustrates a typical compensating piece for clamping details of this type, and the moving jaw is fitted with a pivoting clamp which automatically assumes a position relative to the angular edge. The pivot is substantially made, and as the circular portion of both these items fit closely together, a heavy clamping pressure is possible, a factor which is generally essential when holding rough and awkwardly shaped articles. Incidentally, a more tenacious grip is secured by serrating the clamping faces in a manner practised with the standard type of jaw and for such items of equipment as four jaw chucks.

Not all compensating pieces are employed for holding this class of component because a useful medium is found for them when two workpieces are held in the same set of vice jaws as shown at Fig. 8. Again the drawing portrays the somewhat massive chracteristics of this clamping device, and it is usual to harden the wearing surfaces against damage caused by swarf and possible contact with the cutters.

Holding circular components with the usual style of vice jaw is never successful, and a host of different ideas is employed for this class of work chiefly in the form of special sets of jaws. However, a useful piece of equipment is depicted at Fig. 9, consisting two blocks in which a series of vees have been machined at right angles to each other for holding circular details. This type of jaw is admirably suited for the standard machine vice when numerous round parts are continually required for simple operations on the ends or in some cases on the diameters. While such a set of jaws is seldom permanently attached to a vice and lateral location is thus possibly not so accurate as with those jaws normally screwed and dowelled in place, nevertheless this equipment is time saving and economical in tool costs with small batches or when a single item is encountered.

Round material is again catered for in the next design at Fig. 10, where a part is held horizontally for perhaps finishing the ends and milling a groove in the centre. Clamping between two vees is common practice, but as the piece is set above the level of the jaws an opportunity is taken to provide

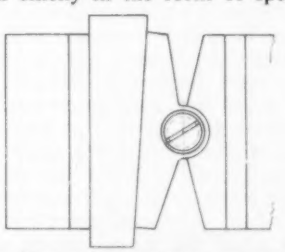


Fig. 7.—When castings and forgings are machined in vice jaws, a compensating action is essential to overcome variations in shape and size of the component. The two-part member shown here is the usual way of providing this form of clamping

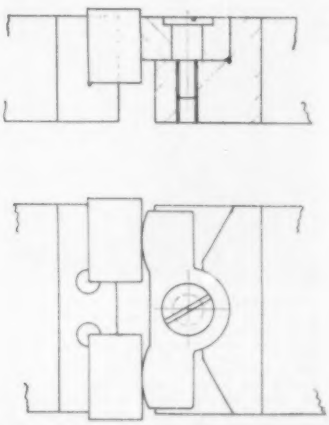


Fig. 8.—Clamping two components in the same set of jaws is accomplished with the aid of a compensating piece; a method which naturally reduces production costs

each member with a step and so eliminate a tendency to tilt under the influence of a heavy cut. Such a provision often means that a vice can accommodate articles considerably longer than the width of a vice, and though the latter is frowned upon as being not good shop practice, the use of a substantial set of jaws with this step machined as shown here will often allow the machining of a shaft several inches longer than is generally permitted with a particular type of vice.

Fig. 11 utilizes the principle of springing the fixed jaw for clamping two components—a principle which is not always entirely satisfactory as there is the tendency either to make the jaw too massive and thus excessive pressure is necessary during the final tightening operation, or the jaw is so weak that the centre portion can snap off and so make replacement essential. The design does, however, serve a useful purpose when light cuts are taken and therefore similar pressures are used.

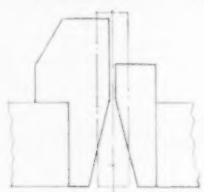
Standing shafts vertically introduces an awkward operation and the length of many details makes such a practice impossible as the height of a jaw on a vice is not enough to give the necessary degree of backing to the component. Fig. 12 shows how two vees set vertically can overcome the problem for the shorter type of shaft. Incidentally, these latter drawings show that the lower surface of each jaw is angled for a considerable distance, which apparently adds unnecessarily to the final cost of the jaws. This idea is employed to overcome the possibility of a forgetful operator, or one who persistently fails to clean the jaws properly between each loading, from leaving masses of swarf on the bottom slide of a vice and so eventually causing the jaws to clamp on this material and not hold the articles being machined securely.

Clustering workpieces together in the manner illustrated at Fig. 13, whereby the pieces hold each other, is possible, and though flat location surfaces and clamping faces are shown, the introduction of vees to each vice jaw is feasible though adding considerably to the cost of this equipment. The pressure exerted by the screw or cam operating the jaws is usually high and there is a tendency to burst the sides of the fixed jaw. Thick side walls are thus essential to prevent distortion and eventual cracking of these parts. Stacking short components in this manner is often a more economical way of machining the ends after parting off on an automatic or capstan than again inserting them in a collet for the machining with a facing tool. Coupling the facing cutters with a series of tools for milling a slot in the face is yet another possibility, and the sketch indicates that 14 pieces could be faced and slotted in this manner for a table travel of about 3 in.

Fig. 14 illustrates a set of vice jaws for milling several parts when they are placed in line, and this design utilizes a series of plungers for clamping. The latter are made a close sliding fit in the moving jaw, are prevented from being either forced out or falling from their location by retaining plate, and the opposite ends emerge into a long cross hole bored in the sliding jaw. Each end of this hole is plugged with a large set screw and the holes drilled to facilitate the drilling and boring of the plunger holes are also treated in a like manner. Finally the cavity made by drilling the cross hole is filled with any plastic material or liquid, thick grease, beeswax or similar material are all suitable, and as the clamping pressure is exerted an even distribution is secured which is imparted to the plungers, ensuring that each detail has the same clamping load. This idea is an old one and useful when thin walled parts are being clamped and where an excessive pressure is likely to cause distortion.

Another style of component which is often frequently difficult to locate and hold, and which in some respects is closely allied to the circular details described above, is the dumb-bell workpiece seen at Fig. 15. Machine handles are typical instances where this design is found, and for those occasions when a special part necessitates the use of vice jaws a lateral compensation is

Fig. 9.—Holding circular components of the one-off variety, or where small batches are encountered, is effectively solved with the aid of this type of jaw. The same idea is applicable to other shapes



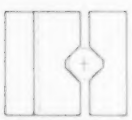


Fig. 12.—Short circular components are securely held in a vertical direction by this style of jaw, and provided the fixed member overlaps the vice the cutters cannot cause a tilting action or severe chattering

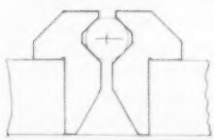


Fig. 10.—Such operations as milling bar ends to length and machining steps or grooves are effectively handled by these simple jaws

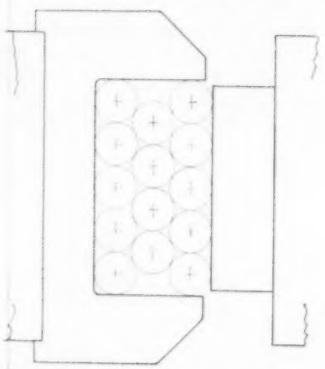


Fig. 13.—Clustering circular components reduces machining costs and the method is valuable even for such simple operations as facing shafts to length. Milling slots and angles on the ends is also possible by suitably arranging the cutters in the gang

Fig. 11.—When light clamping pressures are anticipated and the holding of more than a single component at every load is deemed essential, the springing action of the fixed jaw can be used as shown here. Care is required in operation otherwise there is the risk of fracture of the fixed jaw

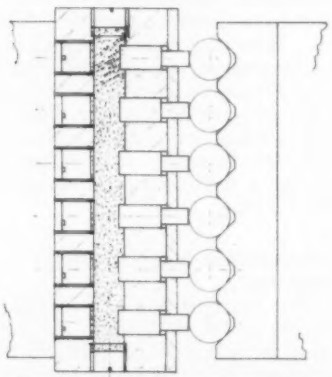


Fig. 14.—An even clamping pressure on each component is achieved with this design, and with thin-walled items there is less risk of distortion. Any semi-fluid material is suitable for the filling behind the plungers

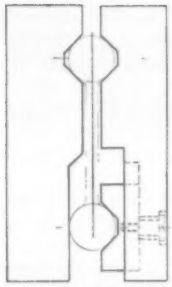


Fig. 15.—Ball ended components need some form of adjustment for location and this set of jaws employs a moving vee to grip one sphere after the initial location by the fixed vees

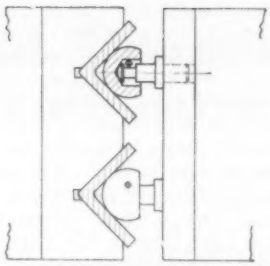


Fig. 16.—Another type of compensating device, used when two angled details are clamped. The spherical seat given to the stalk is sufficient to overcome any slight error

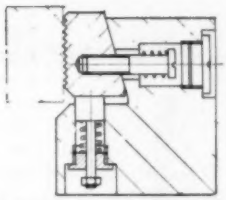


Fig. 17.—A further idea for making a "pull-down"; suitable for either serrated or plain jaws

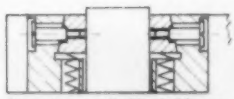


Fig. 18.—A double hold constructed on the lines of Fig. 17. This form of clamp exercises an equal pressure on both faces and is really only suitable for work where the side faces have already been finished machined

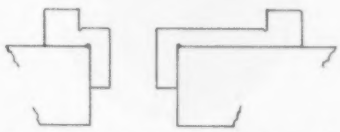


Fig. 19.—This type of jaw increases the capacity of a vice for the occasional encounter with a wide component. The design is restricted to those details which do not require deep cuts

needed to overcome any slight variations that may occur between the centres of the balls. One end is anchored by the opposed vees machined in the fixed and moving jaws, but the method of using the equipment demands the centring of the cross slide, in which a further vee is milled and ground. As the main location is secured from the vees first mentioned, the sliding part is made a comparatively loose fit in the guideways to eliminate any tightness that may occur due to swarf entering the slot, and the vee is moved to an approximate position under the ball by means of a finger pushing it in place. The vee is retained by the shouldered screw. Incidentally this design is useful for jig work when a ball handle is encountered which requires a cross hole drilling through it.

A somewhat unusual design of jaw is depicted at Fig. 16 where two vees are being machined. Here some degree of compensation is secured by using specially machined balls for clamping, and these parts are held in position on stalks by small pins that pass into a groove turned in the shanks. Pressure is imparted on the bottom of each ball by the dome on the stalk, and this allows the ball to move slightly as the pressure given to the jaws is transferred to the components. This design is only applicable when the angles or similar shapes match closely as the amount of movement obtained with the balls is never very great.

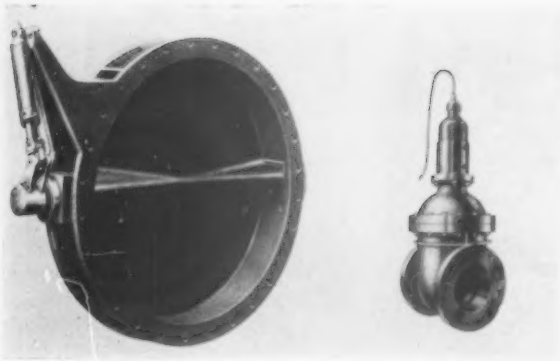
Reverting to the opening paragraphs when pull-down designs were discussed, the incorporation of a sliding member in a jaw which does not require subsequent handling is preferable to loose pieces as the latter are often easily lost during changes in production. Fig. 17 portrays this style of jaw which is applied for holding either rough bar material or finished details; the only difference in the design being the use or otherwise of the serrations which appear in the drawing shown here. Pressure made by closing the jaws causes the serrated part to slide down the incline—only a small movement is expected but this is sufficient to create a downward thrust to seat a workpiece successfully. As there is only a small angle machined on the jaw, the spring underneath the plunger is a light one and is enough to return the jaw to the starting position.

A development of this idea is depicted at Fig. 18 where two pads are treated in this manner, and this design is ideally suitable for components which are finished on the width and need a vertical pull downwards to make them seat correctly. Covering the sides of a jaw to eliminate as much swarf and coolant as possible is essential, otherwise chips can pack under the sliding member and eventually cause it to jam. Thin plates attached to cover up the gaps are thus a useful addition and do not increase the cost to any great extent.

For light cuts on wide workpieces the set of jaws seen at Fig. 19 provide the solution, especially in conditions where numerous single items are machined. Obviously the application of this design is limited as the components are necessarily set high in the vice, but in tool rooms or even on those occasions where a vice is applied for almost every job that requires drilling, the fitting of these jaws to overlap both sections of a vice is a welcome addition and obviates the necessity for lifting a cumbersome piece of equipment on and off the machine.

The above designs are but a few specialized examples which can convert an orthodox accessory into a functional item that can aid production often much more efficiently and economically than an elaborately designed fixture, and the vice scores heavily on two or three counts, perhaps the most important being the speed at which the parts are securely held between the jaws. Again, while milling and possibly shaping operations are generally associated with this class of tooling, the introduction of the jaw principle into jigs and fixtures is feasible and assists in obtaining a speedy clamping arrangement to supplement other ideas used in the design. Most jaws are easy to clean but for those which can become easily clogged with swarf, the incorporation of covering plates, etc., as described earlier, will do much to prevent false clamping of an article and assist in keeping the equipment clean.

HAND PALLET TRUCK WITH LADDER.—A novel development to facilitate selection of orders in stores is this spring loaded stores ladder fitted to a hand pallet truck. The truck has a special hydraulic unit which virtually eliminates oil leakages and maintenance, the pump ram works without a washer, and there is an interchangeable pump cylinder inside the oil reservoir. Fork rollers are made in steel, rubber, nylon or aluminium. The manufacturers, G. Hunter (London) Limited, Gumley Road, Grays, Essex, have exported over 7000 of these trucks to the U.S.A. during the last twelve months



Hydraulic and pneumatic valves with servo actuators for flow control of fluids

Valve Control

A further variation of their actuator which is suitable for hydraulic or pneumatic power operation of pipeline valves, has recently been introduced by Hydraulics & Pneumatics Limited, Wulfruna Works, Villiers Street, Wolverhampton, a member of the Turner Manufacturing Group. The actuator, a patented device, is designed for easy fitment to standard sluice, globe and butterfly valves, and enables more simplified piping installations than hitherto used with conventional cylinders. Control may be manual, hydraulic, pneumatic or electrical, and either open-shut or positional control can be easily arranged. The requirement to hold valves at any desired position without the complexity of external lock valves, is a further advantage of this device.

Oil-resisting Finish

Armour 1172 has recently been introduced by Griffiths Bros. & Co. London Limited, Armour Works, Well Lane, Wednesfield, Staffs. Oil and heat resisting, the product is an air-drying gloss finish claimed to be resistant to transformer, lubricating, diesel and certain cutting oils. Suitable for exterior exposure, it is also said to be resistant to mildy acidic or alkaline conditions and to be able to withstand temperatures up to 140° C.

Its main applications are in the engineering industry, where it is suitable as a coating for sumps, the interior of transformer tanks, and the exterior surface of petrol tanks, but it is also suitable for use wherever a rapid drying gloss finish with rapid setting is required. It is capable of being force dried, which is said to enhance the gloss.

Available in black and 631 light battleship grey, application is by brush dip or spray, direct on clean metal. It touch-dries in 20 min and hard dries in 2 hr or in a shorter time if force dried.

Electronic Temperature Indicator

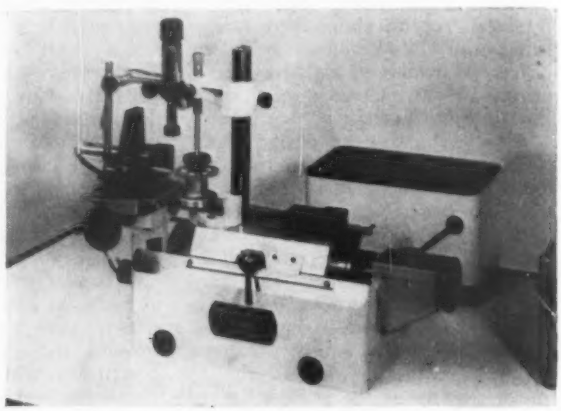
The latest instrument to be announced by Fielden Electronics Limited, Wythenshawe, Manchester, is a precision self-balancing electronic temperature indicator designed to operate with resistance bulbs.

The indicator is presented in a sealed case similar in size and appearance to a mercury-in-steel indicator or to a circular scale electrical meter. Resistance bulbs are used as the temperature sensitive elements and with the inexpensive cable specified, these can be any distance from zero to 300 ft away from the instrument without affecting the calibration or accuracy. No moving coil, or other fragile assembly is incorporated and the indicating pointer is precisely positioned by one of the simplest servo-mechanisms of any self-balancing industrial instrument. Motive power is provided by a d.c. electric motor which has sufficient torque to ensure that the smallest temperature changes are faithfully followed.

A number of standard ranges, both Centigrade and Fahrenheit, are offered, within the normal limits of resistance bulbs (minus 200° C to plus 500° C) but non-standard ranges with suppressed zeros and covering temperature spans down to 50° C can also be supplied. The instrument has a calibration accuracy of 0·5% of range and reproducibility is better than 0·25%

New Sultan Pumps

The new Pegson-Sultan pump is a vertically split, end suction, single stage, centrifugal pump. It is being produced in sizes from 1½ in. to 12 in. suction branch diameter, the entire range comprising 42 pumps with capacities from 20 to 3500 gpm. Major components are interchangeable so that the entire range has only 254 parts instead of the usual 1250. Other design points include: a contemporary styled bearing housing in which the mounting flange is rigidly supported at both the top and bottom; shaft accurately machined and of generous proportions for all loading conditions; a choice of four interchangeable seals—three mechanical self-lubricating shaft seals and a conventional stuffing box with gland packing; all pumps available with engines or electric motors or as pump ends to drive from independent power sources. The manufacturers are Pegson Limited, Coalville, Leicestershire.



Involute tester for use with the Goulder No. 1 rolling gear tester

Testing Small Gears

The No. 1 involute tester manufactured by J. Goulder and Sons Limited, Kirkheaton, Huddersfield, is designed to measure deviations from a true involute of small gear teeth. It is a simple device using basic principles of generation and is intended for use with the Goulder No. 1 rolling gear tester. The tester allows accurate inspection of gears up to 4 in. dia between 20 and 100 D.P., the profile being observed through a microscope for ease of setting. Other features are a special composite stylus incorporating a spring steel feeler and two speed power drive with a standard Goulder power drive unit.

Physical Properties and Applications of Molybdenum

The development of metals for use in rocketry and other high and low temperature applications has revealed to metallurgists that they still do not know as much as is necessary regarding certain aspects of this well-known metal and its application. Over the last few years a good deal of new work has been carried out, and in the notes below some of the results are summarized

ONE of the known phenomena regarding molybdenum is that at low temperatures it passes rapidly from ductility to brittleness. The temperatures at which this change occurs are much closer to the normal than is the case with iron, for example, and the mechanical properties of the element at normal room temperatures are dependent largely on the temperature at which the change takes place. It has been found that the metal may be either brittle or ductile at normal temperature, as directed by its microstructure, so that one of the first requirements is to control this microstructure. For this to be possible, we must know not only how to produce a particular microstructure advantageous for the purpose, but also how to judge the influence it exercises on the tensile properties of the material. Without this knowledge it is impossible to produce the best possible properties and to judge the influence of composition and other factors on the change from ductility to brittleness.

Research has shown conclusively that there is a relation between grain size and mechanical properites, and in particular the ductility, of molybdenum. Non-metallic impurities have been found to have important effects on recrystallization properties, and the transition from ductility to brittleness. The temperature at which the transition occurs may be elevated or depressed in relation to room temperature by merely modifying the microstructure. As regards grain size, if this is increased from 1700 grain/sq mm, the temperature of the transition to brittleness is increased by about 100° C. Microstructure is governed by the preliminary mechanical and thermal treatments given to the metal, and for the best type to be obtained, the utmost care is necessary in processing.

Possibly the most extraordinary property of molybdenum is its high strength at temperatures within the range 870° to 1100° C. Research was, however, necessary to provide increased information regarding the strength of the metal at high temperatures in relation to creep. This has produced evidence to show that the extremely valuable high temperature properties of molybdenum are to a large extent the result of a degree of strengthening produced by temperature and strain, e.g. strain ageing. A conclusion drawn from these facts suggests that possibly a correctly adjusted combination of purity, deformation and heat treatment may be of the utmost value in improving the properties of molybdenum and its alloys.

A property known as delayed or discontinuous yielding is apparent in fine-grained ductile molybdenum under rapidly applied constant stress, as has been proved by a series of investigations, which also had for their object a comparison of the behaviour of the metal in this respect with that of low carbon steel over suitable ranges of applied stress and temperature. A feature that emerged was the presence of distinct yield points in the static stress-strain relations of two lots of the fine-grained ductile molybdenum. There seemed to be a marked similarity between molybdenum and low carbon steel in this respect. It is believed in consequence that these phenomena result from the anchoring of dislocations in body-centred cubic metals by interstitial solutes such as carbon and nitrogen. Nitrogen is apparently more effective than carbon.

Molybdenum has a very low resistance to oxidation at elevated temperatures, and it is this which has prevented its being more widely used in this country for high speed cutting tool steels. Although, as indicated, molybdenum has great value as a structural material for temperatures of 980° C and over, it has to be given a protective coating, and it is important that these coatings should be ductile. Much work has been done to find the most satisfactory means of cladding the molybdenum sheet. The following are methods that appear to be suitable: (a) sealing the cladding assembly under vacuum in advance of rolling; (b) nickel plating the contact faces of claddings which form stable oxide films when heated—slightly less reliable a method; (c) substituting thin sheets of nickel for electrodeposited nickel if the air occluded in the assembly is evacuated—which gives the most consistent bonding. A good way to seal the sheared edges of double-clad molybdenum sheet is to undercut the molybdenum core section by anodic immersion in caustic solution, insert filler wire in the groove so formed, and fuse the edges with an oxy-acetylene blowpipe.

Suitable cladding materials include Inconel, Inconel-X, and 80% nickel–20% chromium on molybdenum. The claddings are 3 mil thick. For still air conditions at constant temperature, where the cladding has been penetrated so that the molybdenum is partly unprotected, un-alloyed nickel and high nickel alloys (up to 92% nickel) give better protection because they form a compound somewhat akin to the high temperature form of nickel molybdate.

The use of molybdenum as an alloy in materials designed to work at high temperatures is well known. It has both a high melting point and a relatively large atomic diameter, which it was believed might enable the molybdenum to function as a solid solution hardened at elevated temperatures. Highly technical researches were carried out, using the electron microscope and other instruments, and the results—so highly specialized as to be virtually impossible to summarize in a few paragraphs—have helped to make heat-resistant alloys more comprehensible. It has been found, for example, that the

occurrence and behaviour of carbides and other constituents in nickel-molybdenum alloys closely resembles their behaviour and occurrence in alloy steels. Titanium carbide appears to be lacking in stability in the presence of molybdenum at certain temperatures, which is surprising, considering the high stabilities of titanium and other carbides.

An unusual feature of metallurgical development has been the increasing interest displayed in alloys of uranium and molybdenum. One such alloy is an as-cast and heat-treated 2% molybdenum-uranium material. Little was known of this, and researches had therefore to be instituted to discover its mechanical properties. It was found that the tensile strengths of the alloy were increased to well over 140 ton/sq in. by heat-treatment. After such a treatment the alloy displayed brittleness sufficient to make it appear of little practical value, but if water-quenched from 850° C, it gave a good combination of properties for low temperature use. However, cross-sectional thicknesses above 1¼ in. were highly stressed and usually failed, often catastrophically. Somewhat improved ductility was obtained by quenching from 1160° C, but this was at the expense of yield strength and tensile strength values. If the alloy was homogenized and furnace cooled, however, a simple and practical treatment, the use of the alloy within the temperature range −198° to 100° C—was held to be practical, especially if ample fillets and the elimination of small radii notches in design were achieved. In these circumstances the alloy could be used where impact loading was an important factor, within the temperature range indicated.

Molybdenum and uranium are also being used together in powder metallurgy. If a mixture of molybdenum powder and uranium powder is hot pressed at about 600° C, the resultant structure consists of discrete particles of molybdenum in a uranium matrix. This structure can later be homogenized by heat treatment for one hour at 900° C, as long as the powder is sufficiently fine, i.e. about 200 mesh. Molybdenum is, in fact, one of the most beneficial addition elements as regards improving the densification of uranium during sintering, and also for controlling the grain size. As the amount of molybdenum is increased or decreased from 0·8% by weight, the density goes down. On the other hand, the best possible composition as far as grain size is concerned appears to be 1·4% by weight of molybdenum.

Molybdenum has recently been used for the bright electrolytic plating with zinc without the use of a dip, an extremely small percentage of molybdenum in the plating solution giving a brilliant surface to the zinc deposit. Molybdenum disulphide is also in regular employment as a lubricant, while the molybdates have been found to have a number of commercial applications. The ammonium salt of molybdenum is being used in the determination of phosphorus in steel, and it has also been found to be a germicide for cloth, a fire-proofing agent, and an intermediate in dyeing wool and silk.

An unusual application of molybdenum discovered of recent years is as an alloy with copper and pure carbon-free iron as a highly corrosion-resistant material, capable of being employed in the manufacture of apparatus for the chemical industry. Another series of researches has shown that coarse-grained molybdenum in the fully annealed condition will reveal cold ductility as long as it has a nitrogen content that is only a small proportion of that shown by the ductile, finely-grained metal.

It has also been shown that, when sintered molybdenum is brittle in the cold state, but if properly cold-worked it takes on a fibrous structure and becomes ductile at normal room temperature. This cold ductility is entirely lost if the metal is annealed at a temperature higher than that of recrystallization, the effect of which is to develop a normal equi-axed grain structure. For this effect to be obtained the fully annealed material must have a fine grain size.

The use of molybdenum and superphosphate has brought about remarkable improvements in the productivity of land. Territories previously regarded as unsuitable for pasture are now capable of supporting productive mixed pastures of clover and grass, and as extremely large areas are sown to mixed pasture, the importance of molybdenum has been amply demonstrated. Generally, about 2 oz per acre is applied. Sodium molybdate is mainly used, and is mixed with superphosphate, although ammonium molybdate and molybdenum trioxide are equally effective. Uneven distribution has been overcome by adding the molybdenum to the sulphuric acid in the manufacture of the superphosphate. In districts where annual rainfall exceeds 40 in. 4 oz of the mixture per acre is needed for the best response.

The increase in operating temperatures and pressures of heat engines has led to the development of new alloys and the better use of materials, based on improved knowledge of their properties. In these developments, steels of alloy type containing molybdenum are playing an increasingly important part. It has been found that the creep and stress-rupture properties of chromium-molybdenum-vanadium steels are excellent. In high temperature castings of this steel, nickel was believed to favour embrittlement, but this effect has been re-examined and the results show no unfavourable effect resulting from a nickel content of 0·5% to 1%. For chromium molybdenum vanadium steels, tests have shown that the 100,000 hr rupture strength is about 15,000 psi at 550° C.

Molybdenum is now being cast extensively in vacuum arc furnaces by the consumable electrode technique. Arc-cast molybdenum is almost of theoretical density and requires no mechanical working to ensure soundness. It is particularly low in gas content, and this is of great importance because oxygen has been found to reduce ductility. The most successful method of working has been found to be extrusion by a French process.

The effect of oxygen, nitrogen and carbon on the ductility of cast molybdenum has shown that it is ductile even with a coarse-grained columnar structure when sufficiently pure.

Round Saw Blades

The limitation of application imposed by the shallow depth of hacksaw and 'junior' pattern frames is believed to have been overcome by the new Dafile coping saw blades. These are circular section blades with teeth all round and are designed to fit the normal coping saw frame. They will cut all materials in common use including steel, brass, copper, plastics, hardboard, plywood etc., in addition to industrial packs the makers, Dafiles Limited, 37 Sheen Road, Richmond, Surrey, announce that for use by handymen, small packs containing two blades are being introduced for distribution through the retail trade.

Semi-conductor crystals are cut on this machine by a diamond impregnated wheel. The feed is steplessly variable

Hydro-pneumatic Cutting Machine

A hydro-pneumatic machine designed for cutting semiconductor crystals and slices and glass tubes for glass to copper seals is in operation at the G.E.C. Semiconductor Division's factory at Hazel Grove, Cheshire. The machine is designed to cut at steplessly variable feed rates from 10 in. to 1000 in. per hr. It is capable of automatic indexing for parallel cuts, the pitch being steplessly variable from 0 to 1 in. by micrometer adjustment. Repetitive accuracy of indexing is of the order of $\pm$ 0·001 in.

The cutter blade consists of a diamond impregnated or bonded wheel, and the high speed spindle unit driving it may be designed for single or two speed operation and for single or multiple cutting discs varying from 6 in. to 4 in. dia. The power available from the generator unit is 2kW. The machine has a general purpose spindle unit to clear work up to about 1¼ in. height above the root of the cutting groove. This unit may be rotated with an eccentric mounting sleeve to increase or decrease the clearance between the cantilever housing and the work, total vertical adjustment being 1 in. Cutter widths vary from about 0·012 in. upwards. The work may be attached to steel plates for mounting on either a 7 in. $\times$ 5 in. magnetic chuck, or on 8 in. $\times$ 8 in. plates which are clamped pneumatically. The work is waxed on to glass plates or attached by synthetic resins.

The machine was designed at the Wembley Research Laboratories of the General Electric Company and is available from Salford Electrical Instruments Limited, Silk Street, Salford 3.

Bright Platinum Plating

A new stable platinum plating solution, known as DNS, based on the complex sulphato-dinitrito-platinous acid, $H_2Pt(NO_2)_2SO_4$, has been made available by Johnson, Mathey and Company Limited, Hatton Garden, London, EC1.

As the bath is acidic it may be used successfully on electrical components and on printed circuits. Platinum from the solution can be deposited directly on copper, brass, silver, nickel, aluminium and titanium. For deposition on tin, zinc, cadmium or steel an undercoat of silver or nickel is necessary. Electrographic tests have shown no evidence of porosity in deposits up to 0·001 in. thickness on polished copper. But above this thickness some slight evidence of cracking may be observed. Microhardness tests on deposits give values of 400 to 450 VPN.

The solution is supplied as a concentrate containing 10 g platinum per 100 ml of solution and for general use should be diluted to 5 g platinum per litre. Glass, earthenware or plastic tanks should be used. The character of the deposits remains unchanged in the temperature range 30 to 70° C, but the recommended operating temperature is 50° C. At a current density of 5 amp/sq ft, and at 50° C, the deposition rate is 0·0001 in. in two hours. By using a solution containing 15 g platinum per litre at 20 amp/sq ft, again at 50° C, a deposition rate of 0·0001 in. in 30 min can be achieved.

Mechanical Packings

Crane Styles 1040 and 1041 mechanical packings are packaged sealing units for use in valves, and in control, compensating gear, and servo mechanisms. They seal positively and are pressure tight on rotary screw and axially moving spindles up to at least 500 psi. Both styles are equally applicable whether the service be one handling relatively harmless liquids such as water, as when corrosives or solvents are being handled. They contain no rubber components.

The two versions are designed respectively for press-in fit or for flange mounting. Temperature limit can be as high as 200° C, depending upon which of the four material codes is recommended. The packings were developed at the works of Crane Packing Limited, Slough, a member of the Tube Investments Limited group of companies.

Style 1040 mechanical packings for shafts of over 1½ in. dia

Style 1041 mechanical packings for shafts of up to 1½ in. dia

Pre-assembled Wiring Units

Pre-assembled wiring units which can effect considerable price economy, are manufactured by British Insulated Callender's Cables Limited, London WC1, and consist of Mineral Insulated cables cut to a specified length, terminated, colour coded for identification, P.V.C. oversheathed and fitted with accessories if required, according to the customers' needs. No work has to be done on site beyond fitting them into position and connecting up the conductors.

All sizes of M.I. cables can be supplied in wiring unit form, including heavy-duty rising mains, and a recent installation at Rainhill, near Prescot, Lancs, when an electrician and his mate completed the first stage wiring of a seven-room bungalow in 5½ hr, indicates economies attainable. In the new headquarters of Shell Petroleum Limited, at present in the course of completion at Waterloo on the south bank of the Thames, 17,000 units are being used for the lighting and power circuits.

Harrison horizontal milling machine

Small Shop Miller

An introduction at the International Machine Tool Exhibition was the Harrison plain horizontal milling machine which is attractively priced primarily for the smaller workshop. It has an all-gear drive from a 2 hp motor and spindle speeds from 67 to 1500 rpm. The spindle is bored No. 30 American National Standard. The table is 30 in. × 8 in. with hand, power and automatic feeds, 15 in. longitudinal, 6½ in. across and 11 in. vertical. A vertical head with speeds up to 3000 rpm is available for this machine.—T. S. Harrison & Sons Limited, Heckmondwike, Yorkshire.

Superfinishing

Superfinishing has established itself as the most advanced method of producing fine finishes of the order of one micro-inch and the Supfina SM 80 centreless superfinishing machine is an example of the range of machines produced by Wieck & Hentzen, Remscheid, Germany, for carrying out this operation.

The throughfeed system provides maximum production and a number of special features aim to give continued quality of finish with ease of operation. The oscillating head is air operated and incorporates a balancing device to obviate vibration. The transport rolls have infinitely variable speeds and the setting of these rolls is controlled by means of a hand wheel. The form of the rolls ensures an absolutely straight line pass of the workpieces through the machine. An air operated pressure roll is fitted at the infeed position of the machine to assist the components to rotate before passing under the first stone. Arrangements are made to impart a constant stone contact pressure even with a fluctuating supply. A filter unit with pump, fine filter and magnetic filter unit provides sludge free lubricant to the stones. An electrically controlled sensing device works in conjunction with the pressure roll to stop the machine automactially when the supply of workpieces ceases and the stone guides are automatically withdrawn.

The machine is distributed in Britain by Charles Churchill & Co. Limited, Coventry Road, South Yardley, Birmingham.

Union T.S.S. tool grinding and lapping machine

Tool Grinding and Lapping

The new Union T.S.S. carbide tool grinding and lapping machine provides for tool grinding, diamond lapping and chip breaker grinding. A range of tool holding devices makes it a versatile machine capable of dealing with all tool angles. The table is ball bearing mounted and measures 11 in. × 6¾ in. It has 3 in. movement and angular adjustment of 20°.—T. S. Harrison & Sons Limited, Union Street, Heckmondwike, Yorkshire.

Unit Heads and Cutting Tools

A comprehensive range of both screw feed and cam operated unit heads was exhibited by the Brooke Tool Manufacturing Company Limited, Warwick Road, Greet, Birmingham, at the International Machine Tool Exhibition.

There will be three cam operated units ranging from ½ hp to 3 hp, these having maximum drilling capacities in mild steel from ¼ in. dia to 1¼ in. dia. Three screw feed unit heads range from 3 to 15 hp with maximum drilling capacities in mild steel from 1¼ in. to 3 in. dia. In addition there is a unit type machine designed for billet drilling and another of a light rotary transfer type.

A complete range of cutting tools, comprises high-speed steel cylindrical milling cutters of all types, including inserted blade facing heads, end mills, both plain, morse taper and screwed shanks, and other types of shank cutting tools, gear cutters, hobs and other form relieved cutters, form tools, both flat and circular metal slitting saws, both hollow ground and with side chip clearance.

Hand and machine reamers in high-speed steel, also expansion and adjustable types are included as well as high-speed steel twist drills, both taper and straight shank, and core drills.

Other items are rapid slip drill chucks, gear pumps for suds and oil, tapping attachments, counterboring sets, machine vices, both plain and swivel both with cam and screw action, Cardinal mark II 3-jaw drill chucks, key operated, with capacities from ¼ in. to ¾ in., Cardinal mark I key-operated and keyless 3-jaw tool room drill chucks with capacities from $\frac{3}{16}$ in. to ½ in., special tools manufactured to suit special requirements; carbide and ceramic or sintered oxide bladed milling cutters; carbide tipped reamers; carbide tipped side and face cutters, metal slitting saws, helical cutters, counterbores, centres and masonry drills; and components for the aircraft industry and similar machined parts for engineering and allied trades.

New Universal Borer

The entirely new Kearns Model 451-P Optimetric horizontal surfacing, boring, milling, drilling and tapping machine with patented hydraulic tool clamping and release to the spindle was shown for the first time at the International Machine Tool Exhibition. Equally suitable for the tool room or general workshop use, this model incorporates many exclusive and patented features. One of these is the main bed construction which is the result of a careful study of the forces involved and deflexions encountered in a universal horizontal boring machine. The cellular bed has a special channel in the centre directly under the centre line of the travelling spindle, to house the longitudinal screw and shaft, together with their associated mechanisms. As it is filled with lubricant, these parts, including the centre bed way, are submerged in an oil bath which ensures ease of operation, a minimum of load on the feed mechanism, freedom from slip-stick, long life and accuracy. The centre guide on the saddle slides in this special bed channel, at the same time the outer ends of the saddle are carried on large rollers which rotate on anti-friction bearings and are supported by the outer bed ways.

Kearns' unit construction system is employed in this machine, each unit having its own automatic and independent lubrication system. For ease of operation, these gear and feed box units are fitted with the latest internal gear tooth type clutches.

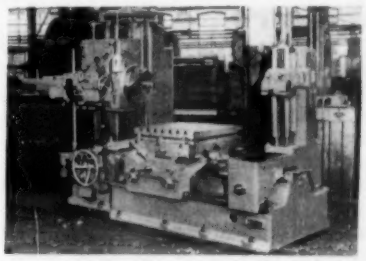
A 7½ hp British Standard totally enclosed foot mounted motor is bolted at the back of the main bed. In this position any heat or vibration generated has a minimum effect on the machine. Drive from this motor is through the latest type of plastic belting to a nine speed gear box. This gear box, which is of the latest design, is fitted with large diameter splined shafts of minimum length and running in ball and roller bearings. A similar belt transmits the power from the gear box to the spindle slide.

Three gear changes in the spindle slide combined with the nine speeds of the main drive box, give a total of 27 speeds to the machine.

The outstanding feature of the machine is its versatility, due to the combination of the travelling spindle with a built-in automatic facing chuck. The travelling spindle is supported at its forward end on a special nitrided cast iron bush which rotates in precision anti-friction bearings. The built-in automatic facing chuck is carried on a large diameter sleeve mounted in two long phosphor bronze bearings.

The feed mechanism to the facing slide is covered by the maker's latest patent and consists of only three simple components. These are the large diameter concentrically mounted worm which drives twin spiral gears working directly into two racks attached to the facing slide. This facing chuck feed mechanism, together with the amply proportioned differential, bearings and gearing in the headstock of the machine, are automatically lubricated from a built-in oiling system.

A new and important feature is the hydraulic tool release and clamping system to the nitrided and superfinished main spindle. This simple mechanism is operated by a rotary switch fitted in the main control pendant attached to the machine. In order to ensure accurate and constant effort when holding the No. 40 non-stick mandrels into the spindle nose, the central draw bar is pulled into position by a powerful spring housed in the end of the main spindle, the bayonet catch enabling the mandrel to be withdrawn easily and quickly. The spring is overcome by applying hydraulic pressure to a cylinder attached to the end of the spindle. This simple mechanism is designed to "fail safe" and enables tool changing to be carried out with great speed and a very high degree of accuracy.

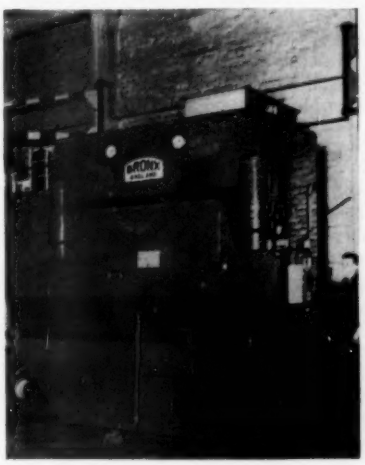


Kearns patent Optimetric horizontal surfacing, boring, milling, drilling and tapping machine with patented hydraulic tool clamping and release to the spindle

The patented Optimetric system is provided to the vertical adjustment of the spindle slide and boring stay bearing and transverse movement of the table. This projection system enables settings to be made to 0·001 in. to a limit of error of plus or minus 0·00025 in. or to 0·01 mm within 0·005 mm. To assist the operator in setting, all the scale mounts are adjustable in their housings.—H. W. Kearns & Co. Limited, Broadheath, near Manchester.

Hydraulic Press Brake

The latest range of Bronx hydraulic press brakes covers machines from 120 to 750 ton capacity. Making use of the latest developments in hydraulic engineering the design allows air bends to be made with an accuracy equal to that obtainable on a mechanical press brake, a feature which is unusual on a hydraulic machine. Whether forming air bends or on bottoming operations the press cannot be overloaded and the rated tonnage is available throughout the stroke.



The top beam can be inched down and reversed at any part of the stroke. Selector switches enable the machine to be set for continuous or single stroke operation, timed well or indefinite dwell at the bottom of the stroke and automatic reversal on reaching any preset tonnage.

The photograph illustrates a Bronx 120 ton hydraulic press brake 8 ft between the columns and 12 ft overall the beams including a 2 ft horn extension on the left-hand side. The machines are made by The Bronx Engineering Company Limited, Lye, near Stourbridge.

Electronic Control

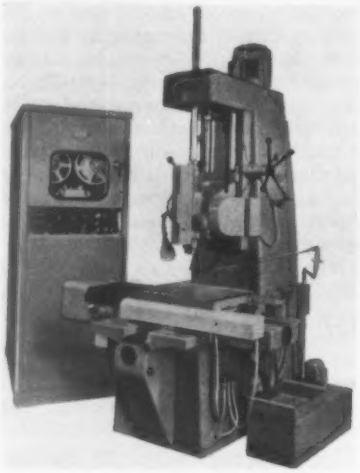
A number of examples of electronic machine tool control made by Associated Electrical Industries Limited, Rugby, were to be found among the machines at the International Machine Tool Exhibition. Kendal and Gent vertical milling machine was in operation fitted with electronic two-dimensional tracing control applied to the table movements. Accuracy of tracing of up to ±0·0005 in. is available with this control which is continuous and has no dead region. The equipment embodies a low-pressure stylus which enables a considerable saving to be made on the model cost. The electronic infinitely variable Ward-Leonard speed regulators controlling the table motions are fitted to the machine as an integral part of the system.

A Kendall & Gent plano-milling machine had an electronic Ward-Leonard feed control for the three milling heads and the table motions. This control incorporates steering control between the chosen milling heads and the table, and also automatic load control whereby feed rates are automatically reduced according to the load on the spindle drive motors.

An Asquith ram type borer was working fitted with AEI electronic control. Among the features of this control are electronic Ward-Leonard speed regulators giving close control, under all conditions of speed and load, to the feeds on the horizontal and vertical motion and the spindle rotation. Using this infinitely variable speed control, gear changes can be eliminated in the feed motions and it has reduced the number from 27 (on previous machines with a.c. induction motor drives) to 4 or 6 on the spindle drive.

Steering control is a feature of this machine whereby the speeds of the horizontal and vertical feeds can be combined so that one control sets the direction of motion without affecting the resultant feed speed and another control sets the resultant feed speed.

The AEI continuous numerical control was demonstrated on Newall model 1520cc jig boring and milling machine. This control features the AEI "Helixyn" position measuring system. All the information required for the functioning of the machine tool is recorded on a magnetic tape



which is prepared by computer techniques from drawings. AEI Electronic Apparatus Division at New Parks, Leicester, offer facilities for the preparation of these magnetic tapes to customers' requirements.

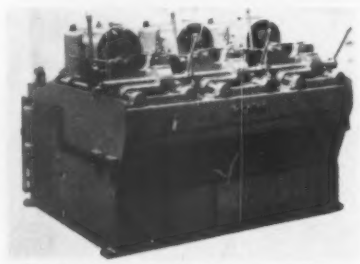
The tapes are prepared for a nominal size of cutter. The shop floor equipment embodies features whereby allowances can be made for cutter sizes other than the nominal. In addition, a tape, once recorded, can be used for both roughing and finishing cuts by allowance being made on the shop floor control equipment.

The AEI system of continuous numerical control is designed to accept spurious tape "drop outs" without affecting the work in hand, but should tape errors be persistent the equipment will be shut down.

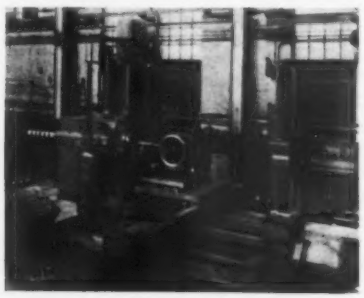
Also shown was a Newall Spacematic jig boring machine fitted with AEI co-ordinate setting control.

Automatic Screwing

Voucher production screwing machines are made with single, double and triple heads and with pneumatic vices. Each head is driven from a separate totally enclosed



Voucher triple head production screwing machine



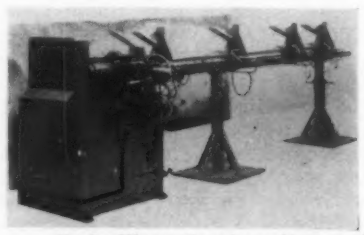
A Kearns No. 3 W.B. horizontal boring and facing machine equipped with AEI automatic co-ordinate setting

Left, a Newall 1520 cc jig-borer fitted with AEI "Helixyn" control on three motions; the "Helixyns" receive co-ordinated signals for controlling the machine movement, translated from the magnetic tape read on the adjacent AEI controller

motor in the base of the machine, via V-belt and variable speed drive, and each has its own tachometer for checking speed. The various models range from ½ in. bolt capacity and ⅜ in. pipe and ¾ in. conduit, to 3 in. bolt, 4 in. pipe and 4½ in. fine thread conduit—Voucher Limited, Essex Terrace, Intown, Walsall, Staffs.

Automatic Sawing

The Voucher-57 automatic sawing machine has a magazine feed for handling bars, tubes or sections, mounted on two or more tubular stands bolted to the machine and adjustable vertically and horizontally. A rigid adjustable automatic stop is provided for precision gauging of cut lengths to a limit of ± 0·003 in. Arrangements are provided for bar



Voucher-57 automatic sawing machine

trimming to avoid waste. The material is held in a duplex work holder which ensures that the product is cut cleanly and free from fraze, and also that the whole bar can be used up. Bar friction is avoided as the bar being cut does not carry the weight of the others in the magazine. —Voucher Limited, Essex Terrace, Intown, Walsall, Staffs.

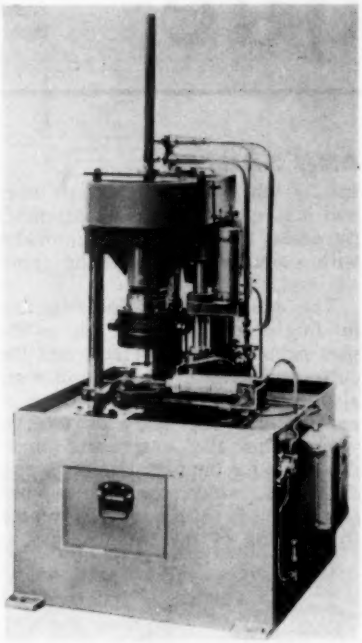
Electronic Control and Inspection

Two new and economically priced control systems acceptable to the small as well as the large engineering company have been introduced by Ferranti Limited, Hollinwood, Lancs. One is a continuous control system which uses transistors, hydraulic servo-mechanisms and a simplified measuring system, to ease maintenance and achieve a cost reduction of 25% or more compared with the old system. The other system is an equipment designed for rapid point-to-point positioning of machine tools and allied equipment in Cartesian or polar co-ordinates. An agreement has been signed between Ferranti Limited and the Bendix Aviation Corporation for the sale of the systems in the United States.

The Ferranti co-ordinate inspection machine provides a rapid means of inspection of machined work-pieces to an accuracy of 0·001 in. This versatile machine utilizes transistorized electronic counting circuits and optical measuring gratings to inspect machined parts by the co-ordinate method. Basically, the principle employed is to have two freely-moving precision slides, which enable a probe to be moved in either longitudinal or transverse directions between the points on the part to be measured. These slides are fitted with diffraction grating measuring systems, which have an elegant direct numerical read-out making the occurrence of reading errors very unlikely. It is sufficiently clear to enable relatively unskilled personnel to undertake inspection work. Inspection times can be greatly reduced by the use of this machine. In one instance, a component which took one hour to inspect by conventional methods was inspected in ten minutes showing a saving of 6:1 in favour of the co-ordinate inspection machine.

Vertical Automatic Tapping Machine

A tapping machine in which the components can be hand fed into the feed tube or hopper fed has been developed for tapping conduit sockets and similar components both in malleable iron and steel. One operator can easily take over four



Voucher vertical automatic tapping machine

machines, and production is seven times the normal from one operator. Components are fed in the feed tube on the top of machine, and then fed in two stages to the tap. The tap has its lead ground on the back against the tap shank, and as the component is fed on to the tap, a vice rises from the base, grips it and feeds down over the tap. The vice opens at the bottom of its feed stroke and the component is ejected from the machine base. No reversing of the tap is required. The tap cutting edges are always flooded with coolant which extends the life between regrinds.—Voucher Limited, Essex Terrace, Intown, Walsall, Staffs.

Six-spindle Conomatic

One of the main characteristics of the six-spindle automatic line of machines made by the Cone Automatic Machine Company Limited, Aldridge, Staffordshire, is the portal construction employing a heavy top bed and base, ensuring great stability and maximum support to the tooling area. A greater length than usual in the tooling area is possible and longer components can be machined. Rigid supports for toolslides and work holding units ensure accuracy and extra tooling positions per spindle make for more machining operations per cycle.

Cams are large ensuring smooth feeds and less wear and cams and cam rolls are easily accessible. Size is controlled through positive stops which ensure that the tension thrusts of the cross slides are taken against the frame—not the carrier. Each spindle is separately served. Ample space is provided in the vase for swarf and coolant and the easy removal of swarf from the tool area ensures longer tool life. These machines range from 1 in. to 4 in. capacity.

In addition there is a $\frac{9}{16}$ in. machine which embodies many of the features built into the larger machines. The feature of stock feeding during indexing permits it to operate smoothly and without fuss in an idle or non-productive time of $\frac{3}{10}$ sec. Independent strokes to all end working and cross slide tool positions allow for tooling and setting the machine to reduce cutting time, and small components requiring several internal and external operations are easily produced at rates of seconds per piece or less.

Multi-tool and Profiling Lathe

The 20 × 40 P5 profiling lathe made by Churchill Redman Limited, Halifax, is designed to give great machine flexibility. Designed on the unit principle the construction can be varied as required to turn out components in the most economical manner and the advantages of profile turning and multi-tool turning can be utilized at the same time.

The basic machine consists of an overhead profile turning carriage and a rear auxiliary infeed slide. The tailstock locates on its own slideways on the front of the lower bed and to these ways can be secured steadies and work supports.

A full range of additional auxiliary toolslides can be fitted to suit specific components, and all these arrangements can be obtained with a completely unrestricted clip disposal area underneath the work. A full range of additional equipment is available, including 3-jaw compensating chucks concentric 3-jaw chucks, steadies, boring equipment and special tooling.

An 8 × 15 profiling lathe is also made.

technique

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Aligning Splines on Long Shafts

A convenient and easy way to machine splined shafts if the quantity makes it an economical proposition to design and make the special cutter and equipment, is by performing the work on the Fellows type gear cutter. In many cases the relationship between the keys at each end of the shaft is not important, and the shafts are assembled in either a fixture or collet without any attempt at pre-setting the members. However, precision instrument work often demands that two or even more of these splined diameters, or perhaps a squared shaft at one end and splines at the other, must align with each other to close tolerances and every shaft which has already been subjected to the initial stages of the work must assemble in the same place in the holding fixture. Once this is achieved it becomes a simple matter to set the cutter, and once this has been done a complete batch of parts is cut and all will match each other, by merely dropping the shafts into the chuck or collet without further attempts at setting.

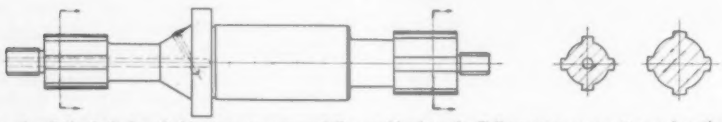


Fig. 1.—Splined shafts of this type are successfully machined on the Fellows type gear cutter, and as there are many occasions when alignment of the key is essential, a special setting is needed once the first keys have been machined

A typical example of this class of component is shown in Fig. 1 where the operations are completed with the exception of the cutting of these two splines—they are of different sizes and it is essential for later assembly purposes that each key coincides with a similar member at the opposite end.

The equipment for locating and holding is seen in Fig. 2 and as the part is turned end for end and the cutter is changed, the location must also be altered at the completion of each batch. The body or base is ground on the outer and inner diameters for the various sleeves and the latter, which can rotate when adjustment is necessary, is prevented from lifting by the two locknuts at the bottom. The inner sleeve is slotted at the top to make a location for the splined bush shown in Fig. 3; a key being fitted to ensure that the bush does not turn in the locating diameter.

The lower serrated outer sleeve is keyed to the body but this is again merely to prevent unnecessary rotation because a sliding action is permissible once the grubscrew, seen at the left, has been released. Immediately above is another serrated sleeve—this with milled V-slots on both sides as shown, and the upper set mesh with still a further, top ring which is keyed and held with a grubscrew in a similar manner; again, sliding of this ring is possible to allow the V-slots to disengage during adjustment.

Setting a cutter for machining these splines is not difficult once the position of a component has been determined in the fixture. The cutter is located and offered to a previously cut or master detail and the head turned until the gaps in the tool match with those on a shaft, but it is the final turning of the master for a few thousandths of an inch that creates setting problems. A fine adjustment on this fixture is secured in the following manner.

The serrated face of the lower outer ring has 100 V-slots. They are of 90° and with reasonable care in use will give long and satisfactory service. They mesh with a similar set milled on the lower surface of the middle ring. The upper face of the latter has 99 V-slots, and these again mesh with an identical number machined in the lower face of the top ring.

To adjust the setting the grubscrew holding the bottom ring to the base is released and the ring allowed to slide down clear of the engaging V-slots. The intermediate ring will also slide with it but in order to secure the required new setting, this ring is turned slightly to move it round one V-slot. This modifies the position of the upper V-slots and as the middle rings are again raised, it becomes necessary to reposition the upper locating ring to make the V-slots coincide with the new setting of the middle ring. Both grubscrews are again locked in position and machining can proceed.

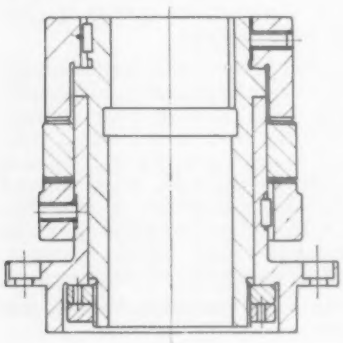


Fig. 2 (left).—This fixture locates on the machine table in the conventional manner and adjustment is effected by moving the serrated rings and then again locking them to the inner sleeve

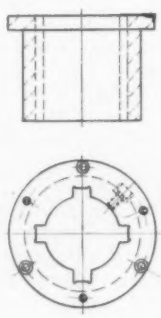
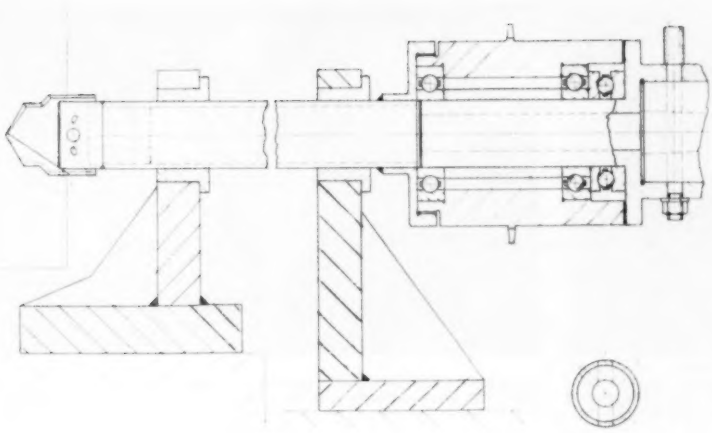


Fig. 3 (right).—When a series of different splines, hexagons or squares are needed on a component, the part is turned end for end at each setting. The use of different bushes of the type depicted here makes the machining of a wide range of details possible for a small outlay once the main fixture is finished

Drilling a Long Forging

A forged shaft 9 in. dia and 5 ft long required a hole along the axis. The only lathe available could not be used because a centre web on the forging would not pass over the cross slide. By making a fixture which was attached to the slide, the forging was made to traverse along the bed when automatic feed



Set up for drilling through 5 ft of solid metal. A power feed was provided. Coolant was supplied through the drill tube

was connected. The drill was driven by a chain and lubricant pumped through the centre of the drill to the cutting tip.

The sketch shows the arrangement. The flat drill was gradually fed into the end of the forging until the largest diameter was cutting well into the metal. At this stage the tailstock travel was used. The sprocket on the motor shaft slid on a splined shaft while this was being done. Once the drill had entered sufficiently the carriage feed was connected and the saddle then traversed towards the tailstock.

Support for the drill was provided by the drill tube passing through two bushes mounted in brackets, one bolted to the lathe bed near the tailstock and the other to the cross slide.

The tube had a plug for locating the drill, drilled to provide passages for coolant. At the opposite end a flanged cap engaged with the sprocket and ball race assembly consisting of two journal and one thrust race. The ball race housing was bored to fit on the front of the tailstock barrel and was secured by a removable pin. Rubber pipe was attached to a branch on the tube and to the pump delivery to pass lubricant to the drill cutting edges.

A slow feed was used to reduce pressure on the drill and to keep the chips small. Some measure of wander on the part of the drill was expected and did in fact take place, but it was not excessive and a later boring operation removed the inaccuracies.

Turnbuckle Technology

Purposes for which different styles of turnbuckles lend themselves admirably are on the increase continually. Turnbuckles are usually adjusted by inserting the end of a pin or bar in the turnbuckle body. There are nevertheless instances where it is found expedient to use a wrench. For that reason, some turnbuckle bodies are made with hexagonal ends.

Threaded fittings applied to turnbuckle bodies are usually in the form of hooks or eyes; the type of turnbuckle desired or employed is generally designated by the nature of these fittings. Thus, one may refer to "eye and eye" turnbuckles, "hook and hook", or "hook and eye". In the latter case, a hook fitting will be used at one end of the turnbuckle body and an eye at the other. Another type considerably used, though less often than hook and eye turnbuckles, has jaw-type fittings. Such fittings have a clevis-like arrangement at the end; they are adaptable for fastening directly to drilled plate-type members, where that is found necessary.

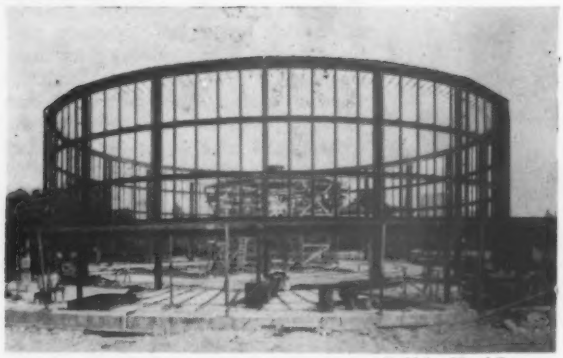
An interesting application of jaw-type turnbuckles is in installation of a saucer-shaped roof on a large modern auditorium. Here, a circular roof assembly is suspended from the outer steel framing of the walls by 200 roof assemblies, furnished by Bethlehem Steel Company. Each of these 200 assemblies incorporates a 44-ft length of wire rope, $\frac{11}{16}$ in. dia. These are extra-high-strength strands, all cables being pre-tensioned and pre-stressed. Pre-stressing was done to limit residual constructional stretch within the prefabrication assemblies to within $\frac{1}{4}$ of 1% of the total length. Stretch for the assembly lengths was calculated to be 0·0069 in. per 1000 lb of load on each strand.

These strands of cable are equipped on one end with galvanized swaged clevises, where they connect to the suspended circular roof structure, and with $1\frac{1}{4}$ in. by 12 in. galvanized "jaw and jaw" turnbuckles on the other end, where they are attached to the circular outer building frame with pins. Obviously, employment of turnbuckles on the supporting cable strands allows close adjustment in the length of each strand; each of the 200 strands bears its proportional share of the entire load.

Turnbuckle fittings above mentioned are considered standard by some manufacturers, including those of jaw type. An occasional instance is found, however, where the manufacturer of a given type of product may find it necessary to dispense with all standard fittings, and incorporate some peculiarly his own. In some of these instances, turnbuckle bodies may be used together with rods which are quite long, though threaded right and left hand in the usual manner where they engage the body.

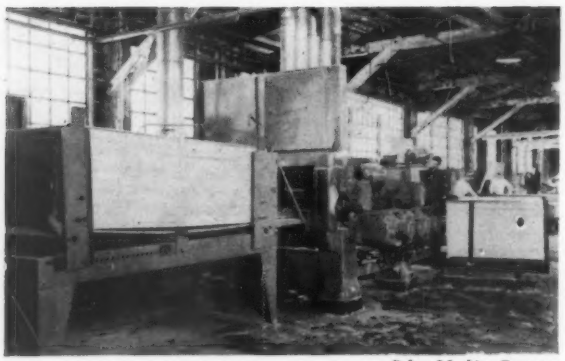
An outstanding case is found in manufacture of retaining clamps, used to retain or hold pressure which has been preliminarily provided by a commercial press. Thus, in the woodworking industries, where it is often necessary to bond material together in volume, flatwise, the stock is spread with glue, laid up in the form of a package, and inserted into a press, on top of a number of I-beams of suitable and uniform length, properly spaced. Before pressure is applied, corresponding I-beams are laid directly across the top of the package.

These I-beams are of a length which allows them to protrude sufficiently past the sides of the package to allow application of the retaining clamps. After adequate pressure has been built up by the press, the retaining clamps are applied to the ends of the I-beams, and the turnbuckle bodies are turned up tightly. Thus, the pressure, preliminarily provided by the press, will be held after the press is opened. This technique allows each package



Bethlehem Steel Company

Steel work of the San Antonio Public Service Board Auditorium, where 200 pre-stressed wire cables were used to suspend the centre assembly of a saucer-shaped roof. Jaw and jaw turnbuckles are used at points where wire cables join the outer high rim of the building



Solem Machine Company

Solem 8-drum doubledeck sander, smoothing both sides of automatically-fed plywood sheets. The automatic feeder is in the left foreground. One of the two turnbuckles used to adjust the angle of the pivoted wedge plate is seen at the near end of the feeder

of plywood or other material to be immediately rolled out of the press, and another load inserted at once. Thus, production is greatly speeded.

As can be seen in some of the illustrations, retaining clamps are essentially large turnbuckles, with rods sufficiently extended to provide the length of clamp needed. Turnbuckles in this case are drop forged; considerably heavier and stronger than standard units. They are fitted with head forgings of tremendous strength, made to slip over the I-beam flanges and take a natural pressure seat on them. The forged head fittings are designed to grip the I-beam close to the web, insuring that no undue strain will be brought to bear on the I-beam flanges.

There are different cases where adjustment facilities provided by turnbuckles have peculiar value in determining and obtaining a desired amount of pitch on given members or structures. They may also be similarly used for actual levelling of suspended structures. There are some instances where gravity-roll conveyors can be suspended from the ceiling of given industrial plants to better advantage than they may be supported from the floor.

Under these circumstances, lengths of gravity-roller conveyor are often suspended on rods, with a turnbuckle incorporated in each rod. Through careful adjustment of these turnbuckles, the desired amount of pitch needed on a given conveyor can be arrived at readily. In this case, (as in any other where it appears expedient), lock nuts can be used behind both ends of the turnbuckle body, and brought up tight after proper setting of the conveyor has been obtained. This insures there will be no change due to vibration.

The Black Brothers Company, Inc.

A "package" of glued-up material, with an extra-heavy caul at top and bottom, and with thinner cauls sandwiched in. This package was put under pressure in an electric press before the retaining clamps (three of which can be seen on the near side of the package) were put in place. The special heavy forged heads at the ends of the turnbuckle rods readily slip over and engage flanges of the I-beams close to their webs. After removal from the press, the package is hauled away to storage until the glue has fully set

Another interesting case where turnbuckles are used advantageously is in providing proper pitch on a pivoted wedge plate, incorporated in an automatic plywood panel feeder. These units are often employed for automatically feeding modern double-deck drum sanders, which are so designed that they smooth both sides of each panel at once, as it passes through. Employment of an automatic feeder eliminates the need for having an operator constantly in attendance at the machine infeed. However, a man is used for off-bearing, as seen in one of the illustrations.

The so-called wedge plate, with which the automatic feeder is fitted, serves to start each panel into the machine as it drops into feeding position. Where panels being fed are relatively rough, this wedge plate must be adjusted at a steep angle. When pre-sanded panels are being run, or when hardwood panels such as birch are being fed, it is set at a low angle. To control the angle of the pivoted wedge plate, a pair of turnbuckles is employed.

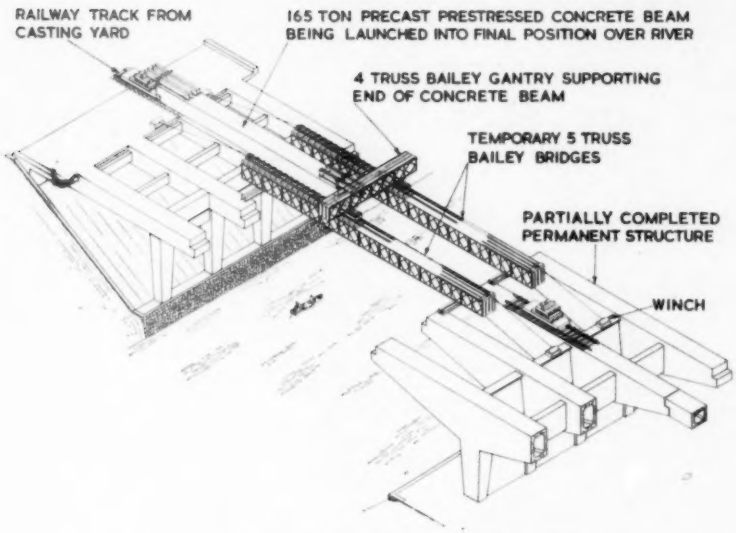
Launching Suspended Span Beams

The precast concrete beams, weighing 165 ton and measuring 83 ft in length, which form the centre section of the Maidstone By-pass Motorway bridge over the River Medway near Aylesbury, are probably the biggest ever to be rolled into position with the aid of a travelling gantry.

The bridge is 325 ft long and 87 ft wide and the main span over the river is 145 ft consisting of two cantilever arms and a central suspended section. The bridge deck is in reinforced concrete, 10 in. thick, supported on four hollow girders of prestressed concrete spaced at 22½ ft centres and cross connected at about 20 ft intervals by reinforced concrete diaphragms.

A requirement of the navigation authorities was that no temporary supports be placed in the river during construction. Although the cantilever arms protrude out over the river, their method of construction was not unduly complicated by this requirement. However, special measures involving heavy temporary bridging were adopted for the central suspended section. The girders of this section were constructed in a casting yard on the West bank of the river and were manoeuvred into position over the river so as to seat on the cantilever arms extending from each bank.

The operation of launching the first girder is illustrated on the



Arrangement for launching centre sections of new Medway Bridge

accompanying drawing which shows the girders of the cantilever arms substantially complete, extending out 20 ft. from the columns on the West bank and 44 ft from the pier on the East bank. Steel joists in pairs were placed at the ends of three adjacent girders of each of these cantilever arms. They spanned the 15 ft gaps between adjacent girders and served as supports for the temporary bridging.

Two Bailey bridges, each made up of five Bailey trusses, were assembled on the West bank, rolled out over the West approach span girders and launched across the 90 ft river gap in the usual manner. The bridges in position, rail tracks were laid on the upper chords and a travelling gantry assembled to span between the Bailey bridges. The gantry itself was made up of four standard Bailey trusses and bearing on bogies travelling on the rail tracks. This travel was controlled by power operated winches mounted on the East and West contilever girders.

With the temporary bridging completed, the first suspended girder was lifted from its bed in the casting area. Bogies were run in under the projecting steel joists which were temporarily attached at each end of the girder. The weight of the girder was then transferred to the bogies by using jacks mounted on the latter. The bogies ran on rail track which extended from the casting yard and thence out over an inner girder of the West approach span. There was a slight incline towards the river and the progress of the girder on its two bogies was controlled by winches.

Upon reaching the end of the West cantilever girder the assembly was halted and the weight of the precast girder transferred from the leading bogie to timber packing erected on the end of the West cantilever girder. The leading end of the precast girder lay between the two Bailey bridges and the travelling gantry was used to transport the unloaded bogie across the river gap to rail track laid on the East cantilever girder.

The gantry then travelled back across the river to pick up the leading end of the precast girder and transport it across the gap. With this operation completed, the gantry and the jacks mounted on the bogies were employed to seat the girder on timber packing erected at the ends of the East and West cantilever girders. Jacks incorporated in these packings gradually lowered the girder into final position on its bearings at the ends of the cantilever girders.

In a similar manner the remaining precast girders will be lifted from their casting beds and placed into position.

The bridge was designed for the Ministry of Transport by Messrs. Scott & Wilson, Kirkpatrick & Partners, consulting civil and structural engineers who are also supervising its construction. The contractors are Sir Robert McAlpine & Sons Limited.

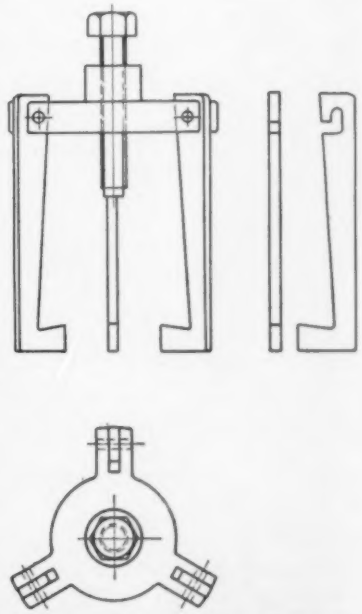
Dual Action Wheel Drawer

The dual action wheel drawer shown in the accompanying sketch will appeal to the maintenance man who must necessarily carry around with him a cumbersome box of tools to make adjustments or repairs to the machinery in his care.

The body is milled from a disc of steel—machining it as shown in the plan view reduces the weight to a minimum and also allows the use of short pins as pivoting members. The three arms are preferably made from a good grade of carbon steel rather than the soft bright mild steel variety as they are subjected to a considerable wear and tear. Each top end is milled to form a right-angled slot that will slide over the pivot pin without excessive shake, and the lower end engaging the wheel is also slightly angled to secure an effective seating on a component. Hardening both ends is essential.

The design has the attraction of being reversible when occasion arises in that each arm is set on the pin to bring the angled ends or feet facing outwards.

—John Waller.



This dual purpose light type pulley and bush drawer has many uses on the lighter class of work where a tight fit is encountered rather than a heavily rusted series of components

Testing the Protective System

By J. L. WATTS

IF the protective system is to perform its safety functions it must be maintained in proper working order. The earthing system should be inspected periodically, any disconnected, broken, loose or corroded earthing connexions being rectified, conduit joints being maintained tight and exposed metalwork on the electrical installation kept clear of other systems such as gas pipes. Fuses should be checked to ensure they are of the correct size. Circuit-breakers need checking to confirm that they are not rendered inoperative due to incorrect current settings, dirt, rust, stiff parts, weak springs, burnt contacts or dirt on the contact faces of electromagnets.

Testing requirements

However, the operation of all types of earth-fault protective gear depends in some way on the impedance of the earth-fault loop. This cannot be estimated accurately, and some part of this loop is outside the consumer's premises in many cases. It is, therefore, most desirable that the effectiveness of the protective system be ascertained by some type of periodical test. The Electricity Regulations of the Factories Acts stress the need for regular and frequent inspection and testing of the earthing system. In premises coming under the Quarries (Electricity) Order, 1956, it is required that the conductivity of the earthing conductors and earth plates be tested by a competent person at intervals not exceeding six months.

The I.E.E. Regulations call for periodical testing. Where earth-leakage circuit-breakers are installed their effectiveness should be verified. Where fuses or overload circuit-breakers are used as a protection against dangerous earth-leakage currents each completed installation and, if possible, each final sub-circuit, should be tested to ensure that the impedance of the earth-fault loop is such that on the occurrence of a fault of negligible impedance, from a phase or non-earthed conductor to adjacent exposed metal, a current corresponding to three times the rated current of the fuse, or 1½ times the setting of the overload circuit-breaker, can flow so that the faulty circuit is made dead. As explained previously it is desirable that the earthing impedance be sufficiently low to cause quick cut-off in the event of any earth fault, to avoid any serious risk of shock.

Tests of solo-connected voltage-operated E.L.C.B. protective system

Voltage-operated and monitored e.l.c.b's are usually provided with a test key which can, and should, be pressed periodically to check that the breaker is free to operate and that the trip coil is connected to its earthing electrode. This test does not ensure that a voltage-operated e.l.c.b. is actually connected to all, or any, of the exposed metalwork it is intended to protect, nor

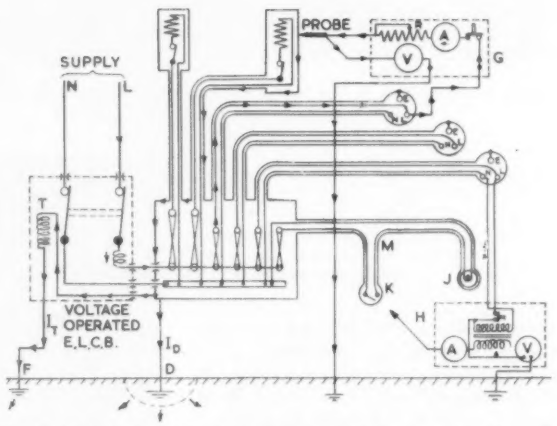


Fig. 1.—Methods of testing voltage-operated earth-leakage circuit-breaker with parallel earthing

that it is not being rendered ineffective by any intentional or fortuitious direct earthing connexion.

If it is certain there is no direct earthing from the exposed metalwork it is practicable to test the protection afforded by a solo-connected voltage-operated e.l.c.b. by momentarily connecting one phase of the supply to various points on the exposed metalwork in turn through a test lamp, and noting whether the breaker trips. The rated current of the test lamp should be little more than the operating current of the trip coil. The effect of a slight increase of the impedance of the earth-continuity conductor has little or no effect on the operation of a solo-connected voltage-operated e.l.c.b. since the volt drop when carrying the low tripping current is negligible. The tests should be made at the ends of each final sub-circuit and at the ends of any branching earth-continuity conductors.

Tests of voltage-operated E.L.C.B. with parallel direct earthing

Where a voltage-operated e.l.c.b. is used with one or more intentional or fortuitious direct earthing connexions the trip may not operate until there is an appreciable earth-leakage current, since most of the current may pass through the direct earthing connexion: and possibly due to the trip-coil earth electrode incorrectly lying in the resistance area of the direct earthing connexion. In any case it is quite possible that, in the event of an earth fault, the voltage between some parts of the exposed metalwork and earth may exceed that applied to the trip coil. Such a system might be checked by using the test key to test the trip and its earthing connexion, with separate tests of the impedance of the earth-continuity conductors

to ensure that, even when carrying earth-fault current equal to the melting current of fuse, or the tripping current of the overload circuit-breaker, an excessive volt drop cannot exist on these conductors.

Another testing device, which gives reliable results even when the trip-coil earth-electrode is within the resistance area of a parallel direct earthing connexion, is indicated at G in Fig. 1. This test set comprises a variable resistor R, voltmeter V, push-button switch and ammeter. One terminal of the voltmeter is connected by insulated wire to a spike driven into the ground outside the resistance area of any direct earthing connexion. The set is fed from a phase conductor and the test probe applied to various points on the exposed metalwork in turn. With the resistor set at a high value the push-button is momentarily pressed to pass a small current to earth through the earth-continuity conductors, this current being indicated by the ammeter, whilst the voltage between the exposed metalwork and the general mass of earth is indicated by the voltmeter.

If the voltmeter gives a low reading, and the voltage-operated e.l.c.b. does not trip, the resistor may be set at a lower value to increase the leakage current, and so on, until the breaker trips or the voltmeter indicates that the voltage on the exposed metalwork is too high. In the latter event the earthing system should be checked It may be that the earth electrode for the trip coil is too near the direct-earthing connexion, or the impedance of the earth-continuity conductors needs reducing.

Another test set is indicated at H in Fig. 1. This employs a double-wound variable-ratio transformer which limits the voltage between the exposed metalwork and earth, the lowest voltage being employed for the first test. Tests should be made to the exposed metalwork at the end of each final sub-circuit, as at J, and also at the end of any branching earth-continuity conductor, as at K. It is possible for unsafe conditions to exist at the lamp switch K, due to a faulty joint in the conduit at M, in spite of satisfactory test results at J.

Tests of current-balance E.L.C.B. protective system

If required the test set indicated at G can be used to test the protection afforded by a current-balance e.l.c.b. provided the set is energized from the circuit controlled by the breaker under test. The ammeter reading just prior to the breaker tripping will indicate if it is operating at its set value. The reading of the voltmeter just prior to the breaker tripping will indicate whether the impedance of the earthing circuit is sufficiently low for safety from shock risk.

The higher the operating current of the protective device the greater is the effect of a slight increase in the impedance of the earth-continuity conductor. In any case the impedance of this conductor from the consumer's earthing terminal to any point on the exposed metalwork should not exceed one ohm.

Measurement of resistance of earth-continuity conductors

Measurement of the resistance of earth electrodes is required in premises coming under the Quarries (Electricity) Order, 1956, and a suitable method has been described previously. In such premises it is also necessary to measure the resistance of the metallic covering of the cables to ensure that this is not less than half that of the conductor of greatest current-carrying capacity enclosed thereby, i.e. that the resistance of the metallic covering is not more than twice that of the current-carrying conductor. For measurement of resistance direct current must be used.

A point which affects both resistance and impedance tests of earthing circuits is that a connexion, such as a conduit joint, may not conform to Ohm's law, i.e. the volt drop across the connexion may not be proportional to the current passed through it. A loose connexion may have a comparatively high resistance when tested with a low voltage and current, but when tested with higher voltage and current, or when an earth fault occurs, the connexion may break down and have a lower resistance. Such a faulty connexion may not be detected if tested with a high current and voltage; although it may deteriorate in time so that it will not break down even under earth-fault conditions.

Another type of faulty connexion may have a low resistance, whilst being unable to carry a high current. Tests at low current may then indicate a low resistance,

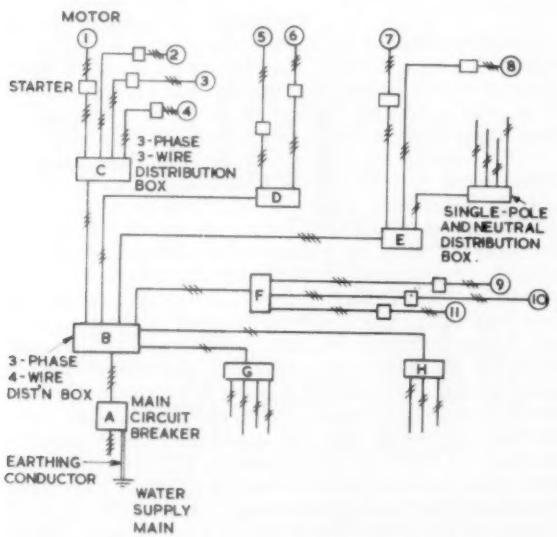


Fig. 2.—Schematic diagram of a section of a power and lighting installation

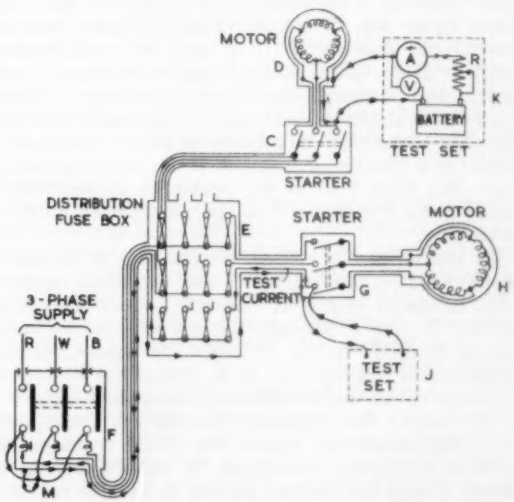


Fig. 3.—Methods of testing resistance of earth-continuity conductors

whilst tests with high current, or an earth fault, may burn out and perhaps open circuit the connexion. It is, therefore, best to make consecutive tests of earth-continuity conductors first at low current, then at high current, followed by a further test at low current to ensure that the high-current test has not burnt out a connexion. Many testing sets incorporate fairly simple methods of applying such tests.

A single-line diagram of the installation, as in Fig. 2, is very useful for testing purposes, since it shows the protective devices for each circuit. The resistance between any two points on an earth-continuity conductor can be measured by using an appreciable d.c. test current from a hand-driven generator or a nickel-alkaline battery.

To measure the resistance between the starter C and motor D in Fig. 3 current from the battery in the test set K can be passed through the variable resistor R and ammeter A through two substantial leads secured to the metal casings of C and D by strong bull-dog clips. Assuming that a high-resistance voltmeter V is used the resistance of the earth-continuity conductor between C and D, plus the resistance of the leads from the test set to C and D, will be equal to the reading of the voltmeter divided by the ammeter reading. The resistance of the connecting leads can be found by repeating these measurements with the bull-dog clips short circuited together. Many testing sets have an instrument which is directly calibrated in ohms. This method can be used for testing circuits which are in use. Tests can be made between the breaker F and distribution box E and also between C and E, the sum of the readings, less the resistance of the connecting leads in each case, being equal to the resistance of the earth-continuity conductor from F to D.

Use of current-carrying conductors for earth-continuity tests

In many cases the use of trailing leads is inconvenient, and another method can be adopted if the circuits can be isolated during tests. The outgoing terminals of the circuit-breaker F may be short-circuited together and connected to the metal casing of the breaker by means of substantial flexible leads M having bull-dog clips. The test set J may then be applied by means of triangular-pointed steel probes to pairs of incoming terminals at points such as distribution fuse boxes, or the motor starter G in Fig. 3 in turn. The resistance measured between the R to W, R to B, and W to B incoming terminals at any given point should be the same. If they are not this indicates that there is a high resistance in a current-carrying conductor which needs investigation. The cause may be a loose or burnt connexion or contact in a breaker or fuse, etc. If the three readings are equal (R_c) then $\frac{1}{2} R_c$ is the resistance of one of the circuit conductors from F to the point tested, as at the starter G.

The test set is then applied between one of the incoming terminals of the starter G and the metal casing of G, as indicated in Fig. 3. The test current then passes between G and F through the circuit conductor, and returns from F to G through the earth-continuity conductor. If the reading is R_e then $R_e - \frac{1}{2} R_c$ is the resistance of the earth-continuity conductor from F to G. To satisfy the Quarries (Electricity) Order, 1956 ($R_e - \frac{1}{2} R_c$) should not exceed R_c. It will be noted that the short-circuiting connexions M can be left on the breaker F and the test set moved to various points on the circuit where tests may be required.

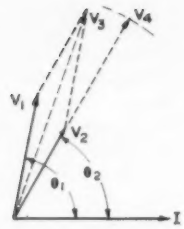


Fig. 4.—Illustrating the effect of differences in power factor of different sections of an earth-continuity conductor

All appliances should be switched off whilst the tests are made. This means that a separate test may have to be made of the earth-continuity conductor between a motor and its starter. The circuit conductors may be used for this test also, or the test set may be used as at K. In the former case the short-circuiting connexions should be placed on the stator terminals of the motor and the testing procedure repeated at the outgoing terminals of the starter. Alternatively, after measuring the resistance of the circuit conductors from F to the incoming terminals of the motor starter G, the final test may be made between one of the incoming terminals of G and the case of the motor H. This test gives the sum of the resistance of the circuit conductor from F to G, plus the resistance of the earth-continuity conductor from G to H.

Impedance tests on earth-continuity conductors

Similar methods may be used to measure the impedance of earth-continuity conductors but, for accurate results, a.c. test current at supply frequency should be used. Some inaccuracy may also be introduced if trailing leads are used with an a.c. test set connected as at K in Fig. 3, due to the reactance of the loop being increased owing to the return conductor (trailing leads) being remote from the earth-continuity conductor under test. This may indicate a slightly higher impedance than the

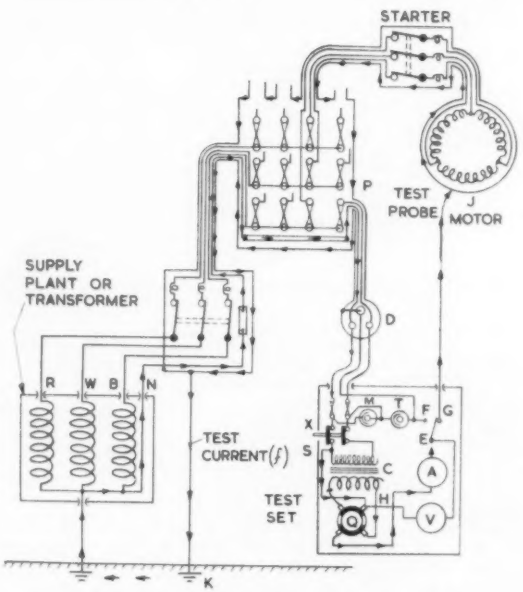


Fig. 5.—General principle of neutral-earth impedance tester

actual value. More accurate results are likely to be obtained by using an a.c. test set connected as at J, since this tests the actual path of the earth-fault current.

It is not strictly accurate to add together the impedances of a series of earth-continuity conductors, unless the conductors have the same power factor. For instance the voltage V_1 in Fig. 4 may be required to pass a test current I amps between two points such as F and E in Fig. 3, whilst the voltage V_2 may be required to pass I amps between E and G if the latter earth-continuity conductor has a lower reactance ratio than the former. If the impedances are added arithmetically the result will be equal to $(V_1/I+V_e/I)$, i.e. to V_4/I. Actually a voltage V_3 between F and G would pass I amp, and the actual impedance between F and G is equal to V_3/I. However the calculated impedance is not likely to be much inaccurate unless the two sections of earth-continuity conductor are of very different construction and, in any case the calculated value will be greater, not less, than the actual value.

As mentioned previously the impedance may be appreciably greater than the resistance if the earth-continuity conductor has a high reactance. In some cases it has been found that the impedance of a run of conduit has been as much as five times its resistance, although such a high ratio is only likely if the conduit joints are of low resistance, in which case both the resistance and the impedance are likely to be reasonably low.

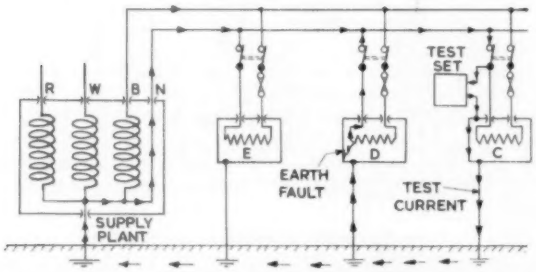


Fig. 6.—Effect of an earth fault on the neutral conductor when using a neutral-earth loop tester

Earth-fault loop impedance tests

In most a.c. circuits the chief test required is measurement of the whole earth-fault loop to ensure that fault current can operate the fuses, overload circuit-breaker, or current-balance e.l.c.b. with sufficient a margin of safety or, alternately, to create an artificial earth-fault to find out if the protective device is adequate.

The I.E.E. Regulations allow that, in cases where multiple earthing of the neutral is not employed, it is permissible to test the neutral-earth loop instead of the line-earth loop. Such tests may be made by injecting current into the neutral earth loop, by means of a double-wound transformer fed from the a.c. mains, or from a d.c. source, the polarity of which is rapidly and continuously reversed. Since this test does not include the supply plant it may be necessary, where the supply is through a small transformer or balancer, etc., to make allowance for the volt drop caused by the impedance of these windings, when carrying earth-fault current. The test current should preferably be about $1\frac{1}{2}$ times the rated current of the circuit, although it need not exceed 25 amp. When a rapidly-reversing direct current is used to test an a.c. circuit it is necessary to ensure by inspection that no choke is incorporated in the earth-continuity conductor.

When testing an a.c. circuit with rapidly-reversed direct current, or with alternating current of less than 10 amp, the actual impedance of the part of the loop from the consumer's earth terminals to exposed metal on the final sub-circuits should be taken as twice the measured value if the earth-continuity conductor is wholly or mainly of steel conduit or pipe. In these circumstances the impedance of the earth-fault loop to a point on the consumer's circuit should be taken as twice the measured value, less the impedance of the earth-fault loop as measured at the consumer's earth terminal. When testing with a.c. over 10 amp at supply frequency the measured fault-loop impedance at any point may be taken as the actual value, subject to correction for impedance of a small transformer, etc.

Neutral-earth loop tests

Fig. 5 indicates the principles of a neutral-earth loop tester, The primary windings of the transformer C are

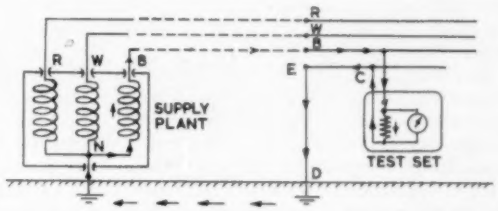


Fig. 7.—Connexions for use with the "Megger" phase-earth loop impedance tester

energized from the line and neutral sockets of the socket-outlet D. The neon lamp M indicates when supply is available at the socket-outlet, whilst the lamp T shows whether the socket-outlet is correctly connected. When the moving contact E of the two-way switch is on the fixed contact F the test current from the transformer secondary winding will pass through the neutral-earth loop to D. The result obtained by dividing the reading of the voltmeter V by the reading of the ammeter A gives the measured impedance of the neutral-earth loop to D.

When the moving contact E is placed on G and the insulated test probe applied to the case of the motor J the test current then flows as indicated by the arrows. The loop tested then includes the neutral conductor from the earthed neutral point of the supply to the socket-outlet D, plus the earth-continuity conductor from the earthed neutral point to the motor casing J. It will usually be sufficiently accurate to take the reading of the voltmeter divided by the reading of the ammeter as the measured impedance of the neutral-earth loop to J.

Precautions

One disadvantage of the neutral-earth loop tester is that there may be an appreciable volt drop in the neutral conductor due to out-of-balance load current. Thus the reading of the voltmeter with a given test current may be influenced by the out-of-balance current, giving an inaccurate result. Some compensation for this neutral volt drop must be adopted. One method is to use a reversing switch, as at Q in Fig. 5, so that the phase of the injected current can be reversed, the mean of the two impedance readings being taken as the measured impedance. Other and more accurate methods of compensation may be provided in some test sets. In practice test sets are usually calibrated to give a direct reading of the measured impedance in ohms.

Effect of earth fault on the neutral

Inaccurate results may also be obtained with a neutral-earth loop tester if there is an earth fault on the neutral conductor at any point, thus this method of test is useless for a system employing multiple earthing of the neutral. Fig. 6 shows that the injected test current from the neutral-earth loop tester applied to the plant of the consumer C may partly pass through the earth fault on the neutral of the consumer D, which forms a parallel path to the neutral-earth loop to be tested. This path will exist until the fault is cleared or the consumer D opens a double-pole switch controlling the faulty circuit.

Other uses of a neutral-earth loop test set

The tester can be used to find the measured impedance between the exposed metalwork and the general mass of earth; i.e. the impedance of the consumer's earth electrode and earth-continuity conductor. For instance if the test probe is applied to J in Fig. 5, and the voltmeter connected between E and an earth spike outside the resistance area of K, instead of to the reversing switch Q, the measured impedance will be that between the casing of the motor J and earth.

Similarly if, with the test set energized from any convenient point, the connexion S is removed from the reversing switch Q, S and the test probe may be applied to any two points on an earth-continuity conductor to measure the impedance between those two points. If there is a convenient socket-outlet from which to energize the set the points S and the test probe could be used as were the test probes from the test sets represented at J and K in Fig. 3.

Phase-earth loop testers

The I.E.E. Regulations allow for the use of phase-earth (line-earth) loop testers which, in many ways, give more accurate results than neutral-earth loop testers, and can be used on P.M.E. systems since they are unaffected by earth faults on the neutral. The Megger line-earth loop tester allows a current of approximately 20 amp to pass through the earth-fault loop and a 10 ohm resistor, for 5 cycles (see Fig. 7). The current through the resistor depends on the impedance of the earth-fault loop, and the volt drop across the resistor is applied to a ballistic instrument which is calibrated with the impedance in ohms. The instrument is also marked to show the rating of circuit fuse for which the earth-fault loop is adequate in accordance with I.E.E. Regulations.

The Ferranti phase-earth loop tester is indicated in Fig. 8. It has a selector switch having various current settings corresponding to the current rating of the fuse protecting the tested circuit, or which could be set at a higher value than the fuse rating if desired. Various safeguards are incorporated to avoid danger due to incorrect connexions or inadequate earthing on the installation. When the push-button G is pressed the phase-condutor at the socket-outlet H is connected to the earthing socket through the selected resistor, the artificial earth-fault current thus created being cut off in 1½ cycles by the miniature circuit-breakers D and F.

It is first necessary to confirm that there is an earthing circuit by setting the selector switch C so that, when G is pressed, the check lamp J is connected between the line and earth sockets at H. If there is an earthing circuit the volt drop across J causes the cold-cathode triode valve K to glow until the switch M is reset. The selector switch C may then be set to correspond to the minimum satisfactory conditions for a circuit protected by a 15 amp fuse and the test repeated. This procedure can be repeated up to the required current value within the range of the test set, afterwards repeating the test with the check lamp to ensure that the earthing circuit has not been open-circuited by the test current. The set can also be arranged for use on three-phase three-wire circuit, on a system having earthed neutral point, even when the neutral conductor is not available.

Testing technique for final sub-circuits

Normally a higher earth-fault loop impedance may be permissible at an appliance, connected on a final

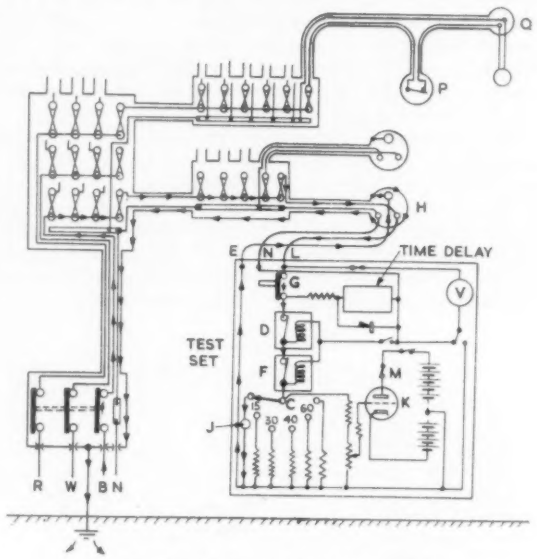


Fig. 8.—Use of the Ferranti phase-earth loop tester

sub-circuit, than would be allowable at a point nearer the supply terminals which is protected by a fuse of higher current rating. Thus, for a complete test, it may be necessary to measure the fault-loop impedance at intermediate distribution fuse boxes, or overload circuit-breakers, as well as at the ends of final sub-circuits; unless the fault-loop impedance at the end of each final sub-circuit is low enough to melt the main fuse with the required margin. The earth-fault loop impedance at the end of a branching circuit also may be greater than at the end of that final sub-circuit. Thus earth-fault loop tests are advisable at the end of any branching circuit, and may be necessary at each distribution point.

Difficulties may arise in testing final power and lighting sub-circuits in a large installation, since it may not be a simple matter to keep track of the size of fuse which protects each point, to which the fault-loop impedance must be related. The following method is suggested for dealing with such final sub-circuits. At a convenient time the size of fuses in each final distribution box feeding a section of the installation should be checked and noted, with particular note of the largest size of fuse in each box. Each fuse should, of course, be small enough to protect the supplied cable, in accordance with I.E.E. Regulations, and the correct sizes should be marked in each distribution box.

The fault-loop impedance to each necessary point on

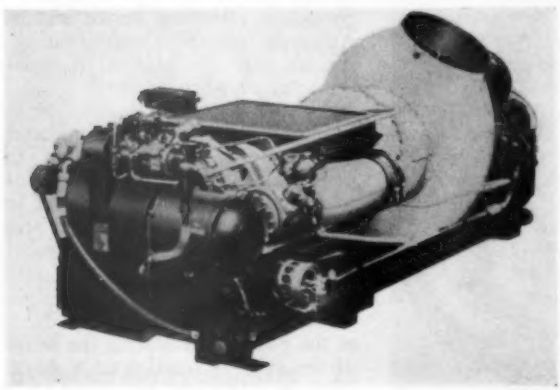
the exposed metalwork of the section fed from any one final distribution box should then be measured. The test set should be fed from a convenient socket-outlet, preferably fed from the same distribution box, passing the test current to the various points on the exposed metalwork in turn instead of to the earth socket of the outlet used to energize the test set. If, in all cases, the fault-loop impedance is low enough for the largest fuse in that final distribution fuse box, with the required margin, the earthing to all the exposed metalwork in connexion with that distribution box can be considered satisfactory.

If the impedance to any particular point on the exposed metalwork is too high for the largest fuse in the distribution box, the fuse which actually protects that particular final sub-circuit can be traced and checked to see whether it is small enough. However a better plan is to overhaul the earth-continuity conductor to make the fault-loop impedance, to that particular point, low enough to melt the largest fuse in the distribution box, with the required margin. In this way a good deal of time can be saved, and tedious work can be avoided.

Small Gas Turbines

Exclusive rights to manufacture and sell throughout Europe, Africa and the British Commonwealth, excluding Canada, all Jupiter gas turbine engines developed by the Solar Aircraft Company, California, have been acquired by Perkins Gas Turbines Limited, Peterborough. These engines are suitable for marine and other applications. At present the British company is producing only the 50hp Mars, but plans to put other Solar engines into production in the near future.

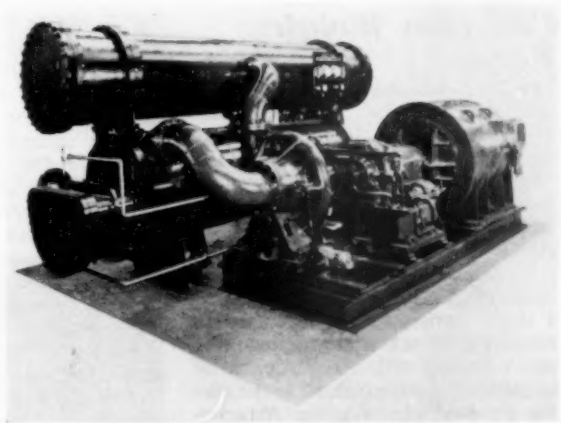
The Jupiter is produced in constant speed single shaft and variable speed two-shaft versions and has a continuous power output of 575 hp at 60° F air inlet temperature and 4 in. water inlet and 6 in. water exhaust duct losses. Overall engine dimensions are 75 in. × 42 in. × 32 in. approximately and weight is less than 1,000 lb. Instant push button starting from—65° F to 130° F is achieved by means of an automatic control system. Full load is attained in 45 sec with electric motor starting and in 10 sec with a combustion air starter. The unit may be operated with a variety of liquid and gaseous fuels including diesel oil, paraffin, low-grade petrol and natural gases. The two-shaft version provides an inherent "torque-converter" characteristic of 2:1 ratio.



Jupiter gas turbine

Turbo Water Cooling

A single stage turbo water cooling system in capacities ranging from 115 to 600 ton is being produced by York Shipley Limited, North Circular Road, London NW2. This compact self-contained turbo package, which includes a single stage turbo compressor, any type of prime mover, refrigerant condenser, water cooler, purge unit and safety control panel and Freon refrigerant, can be operated by unskilled personnel or by automatic control.



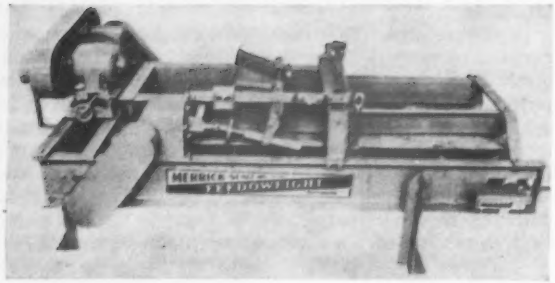
York single stage turbo water cooling package system

Among its features are pre-rotation-vane capacity control which permits a range of capacity reduction from 100% to about 5%; an integral force-feed lubrication system; a specially designed steel shell condenser with cooling water carried through finned tubes of non-ferrous metal and a steel perforated baffle uniformly distributing refrigeration vapour; a similarly constructed evaporator; and a self-contained purge unit to release any air, water vapour and non-condensable gases collecting in the condenser. The York turbo is equipped with panel mounted high and low pressure gauges and refrigerant control.

Photoelectric Relay

The photoelectric relay, a light actuated switch, which can perform any control function whenever a light beam is broken or varied in intensity, has many uses in industry. These include stopping and starting of conveyors, loop control, paper breakage alarm, automatic spraying, machinery guarding, automatic door opening, conveyor and machine jamming detector.

The control operation is initiated by the breaking of a beam of light focussed by a projector on to a photo-transistor. The control unit is contained in a pressed steel housing with hinged lid and consists of an electronic circuit and relay with two sets of single pole changeover contacts capable of handling a load up to 5 amp 200v non-inductive. For a greater load an auxiliary contactor can be supplied. Projectors are available for beam lengths of from a few inches up to 100 ft. The manufacturers are Photoelectronics (M.O.M.) Limited, Oldfields Trading Estate, Oldfields Road, Sutton, Surrey.



Available accessories make this Merrick "Feedoweight" machine most versatile

Constant Weight Feeder

The latest addition to the range of products of The Merrick Scale Mfg. Company Limited, Albert Street, Bulwell, Nottingham, is the "Feedoweight", a constant weight feeder capable of accurate performance in dealing with almost all classes of bulk materials from powders to lumps. It is suited for ensuring peak and accurate feed of a single material or, when used in multiples, for material proportioning and blending with a high degree of consistency. Accessories make the the Feedoweight versatile. A tachometer generator and indicator can be fitted which enable the operator to preset output over the entire capacity range. Controls and belt speed change may be effected from a remote position. A remote 6-figure set-back totalizer can be fitted in conjunction with the master weight totalizer.

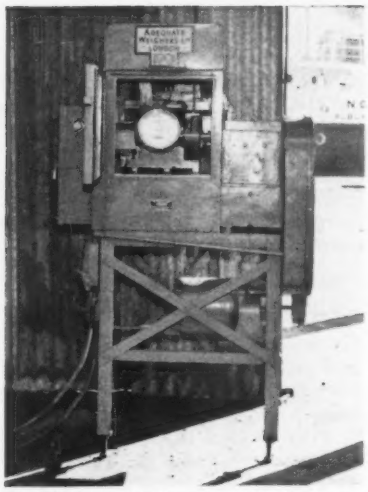
To provide a permanent continuous record of output an electrically operated continuous strip chart recorder, operating in conjunction with a frequency responsive tachometer generator can be supplied. A circular chart recorder operating from an electrical contactor device is similarly applicable.

Oil Burners

As a supplement to the existing range of pressure jet burners, Brockhouse Heater Company Limited, 25 Hanover Square, London W1, have introduced a range of fully automatic medium pressure air burners for central heating and steam raising applications. Made in similar sizes to the existing FAP and M range and designated MPA in the case of "on/off" burners and MPAM for modulating machines, the ratings and general dimensions are similar to those for the FAP series.

Essentially the new burner consists of a combined air compressor and fuel pump mounted concentrically with the driving motor and fan impeller in the conventional manner. The fuel and compressed air are conveyed to the burner tip through separate channels, the atomization taking place at the final orifice of the atomizer. The atomizer is of duplex construction comprising a pressure jet swirl type nozzle surrounded by a larger swirl nozzle which carries the compressed air. The first stage of the atomization is therefore completed by pressure jet and the second by the impingement of the compressed air on the fuel spray. A shut-off valve is located behind the fuel nozzle and circulation around the shut-off valve is provided before ignition in a similar manner to that used with the FAP machines.

LOW FLOW INDICATOR.—A new addition has been made to the range of flow indicators designed and produced by Liquid Systems Limited, Holmethorpe Avenue, Redhill, Surrey. Known as the Model 180 it was primarily designed to give a positive indication of flow only when the flow-rate exceeded ½ of a pint per minute. It can be modified to indicate other rates of flow and on receipt of the necessary information the indicator can be supplied set to the desired flow-rate



The Adequate automatic gross weigher for ropeway conveyors

Intermittent Gross Weigher

The "Adequate" intermittent gross weigher has been designed to provide a fully automatic instrument which will record the weight of material carried over a system of aerial ropeway conveyors. It does not require any attendant operator, nor does it halt the flow of containers at any stage. The machine, manufactured by Adequate Weighers Limited, Bridge Works, Bridge Road, Sutton, Surrey, comprises a lever system with a pedulum resistant, a pendulum clamping device and the Adequate integrator incorporating a special gear mechanism to isolate the totalizer when required.

As soon as a skip is fully on the weigh rail, it trips a switch releasing the clamping mechanism on the pendulum and allowing the pendulum to adjust itself to the weight of the skip, and then starts a time relay mechanism. Before the skip moves off the weigh rail, the time relay mechanism operates the clamping mechanism to hold the pendulum at the position indicating the weight of the skip. A fraction of a second later, it starts the recording cycle. The special gear mechanism engages the totalizer with the continually running integrating mechanism for the precise period of time required to record the weight of the skip. Whilst the special gear mechanism disengages the totalizer as soon as the weight is registered, the pendulum resistant remains held firm at the position indicated by the last weight until the next skip releases the mechanism.

Lodematic pedal-powered hydraulic drum stacker with tubular forks

Drum Stacker

Tubular forks are fitted to the new foot-powered, twin-speed, hydraulic drum stacker introduced by Lodematic Limited, Clitheroe, Lancs. Of telescopic design, it is only 28 in. wide with the overall height decreasing as the forks lower so that low doorways and narrow gangways can be easily negotiated.

Drums of up to 500 lb can be raised at a steady speed, whilst lighter drums are lifted more rapidly; a knurled knob at hand level controls speed of descent, and drums can be halted at any height for discharge. Needle bearing wheels, for ease of movement, are located in the straddle arms and oversize wheels are available where it is required to propel the drum stacker over uneven ground or considerable distances. A parking brake and "plug-in" mains and battery powered electric versions are available.

Acid-degreasing Plant

Latest of the "Turbro" range of chemical plant and equipment is a complete acid-degreasing unit comprising 10 ft and 20 ft long heated acid tanks, rim fume extraction, fans ducting, pipework, wash tanks, soap and creosol tanks. The equipment has been designed, manufactured and installed by Turner and Brown Limited, chemical plant engineers, Bolton, to the instructions of the Ministry of Works for use at a Government research base.

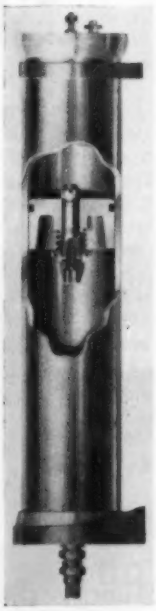
The majority of the equipment including the acid tanks is manufactured from Cobex Rigid P.V.C. reinforced with glass fibre. The acid tanks contain concentrated nitric acid, at ambient temperature, a mixture of nitric and hydrofluoric acid heated with "Carbinert" immersion heaters and concentrated hydrochloric acid. The design of the rim fume extraction system allows maximum accessibility to the tanks; since the ducting forms an integral part of the tanks, mechanical or accidental damage is reduced to a minimum by reason of the constructional material. The equipment is primarily used for the de-greasing of fabricated stainless steel pipes and fittings.

Acid degreasing unit made largely in P.V.C. reinforced with glass fibre

Hydraulic Accumulators

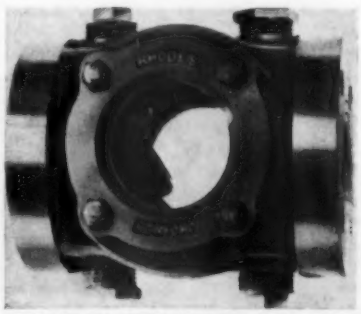
Three new series of hydraulic accumulators have been added to the existing range manufactured by Industrial Hydraulics Limited, 101 London Road, Reading, Berks. All are of screwed end construction incorporating safety interlocks to prevent the unit being dismantled whilst under internal pressure. Series II is for pressures up to 2000 psi with capacities ranging from 8 to 20 gal, Series III for pressures up to 5000 psi with capacities ranging from 1 to 8 gal and Series IV for pressures up to 5000 psi with capacities ranging from 8 to 20 gal. Various port sizes and flanges are available.

The accumulators embody the patented liquid seal piston assembly, designed to overcome one of the main problems encountered with all gas loaded piston separator type accumulators—that of sealing the gas charge when the hydraulic system is shut down and preventing the high pressure gas charge from



The latest "Liquid Seal" hydraulic accumulators incorporate a patented piston separator

leaking into it. In these new accumulators a probe seals the oil outlet when it is discharged so that the oil trapped in the space between the piston and the end cover acts on the area less than the full piston area by the amount covered by the port sealing ring. This in turn means that the pressure of the trapped oil is greater than that of the gas charge in the ratio of full piston area/area acted on by trapped oil. In this way the problem becomes simply one of retaining oil under a lower differential pressure and should there be any leakage this would be of oil into the gas chamber rather than the troublesome one of gas into the hydraulic system. All three series of accumulators are also available with plain pistons.



SIGHT FLOW INDICATORS.—This is a steam jacketed version of one of the standard types of sight flow indicators made by B. Rhodes and Son Limited, Queen Street, Romford, Essex, in a size range from 1 in. to 4 in. nominal bore in any metal or alloy. Also produced are sight flow indicators ranging from ¼ in. to 15 in. nominal bore in metals varying from cast iron to pure nickel including stainless steel, monel and similar chemical resistant alloys, and also lined with rubber, hard acid resisting enamel and plastic

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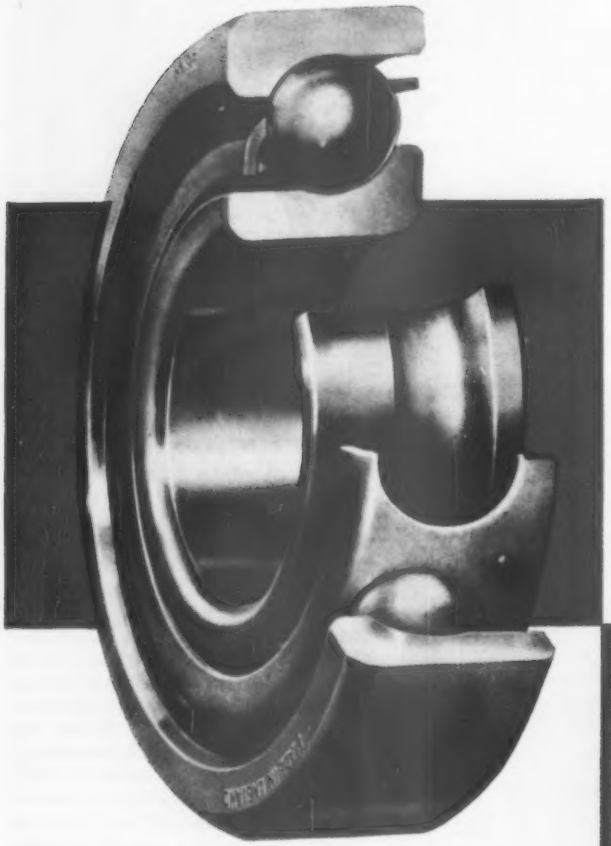
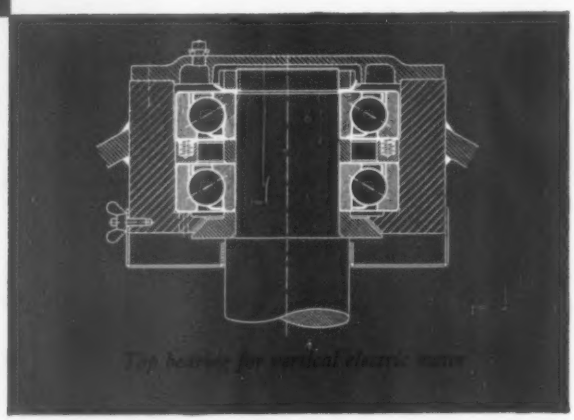


In the single row angular contact ball bearing, the line joining the ball contact points forms an acute angle with the bearing axis. Bearings of this type are therefore particularly suitable for carrying both radial and heavy axial loads, being used in conjunction with a similar bearing dealing with axial forces in the reverse direction.

The problem of which type of bearing to use under given design conditions can be readily solved by utilising the immense fund of technical knowledge which is freely available to you from SKF. The Skefko Ball Bearing Co. Ltd., the only British manufacturer of all four basic types of ball and roller bearing, can offer advice which is completely unbiassed by manufacturing considerations.



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books

High Productivity in Heavy Engineering. By A. G. Thompson, B.Sc., A.M.I.C.E., M.I.E.S., A.M.I.W. London, 1960; Iliffe and Sons Limited. 65/- net (by post 66/3). 339 pp. $8\frac{3}{4} \times 5\frac{1}{2}$ in.

Subtitled "Production, Inspection and Cost Control in Welded Fabrication", this is the work of an industrial consultant who has made a special study of the revolution in industry brought about by the advent of arc-welding. The book is in two parts, the first being a detailed treatment of the technology built up around arc-welding and the second an account of the costing methods most appropriate to heavy fabrication.

Following an introductory chapter outlining the subject, the layout and organization of fabrication shops for different industries and dimensioning methods are described. A long section covers the metal working processes concerned in the cutting or shearing and bending of cold metal; details are given of the purpose, working principle and range of the various machines now used for these processes. The other chapters in this part deal at some length with the assembly of materials after machining, the main welding processes, and quality control and inspection. The methods of measuring work, productivity and cost in heavy fabrication can differ considerably from those used in mass or batch production and in the remaining chapters the author shows the specialized approach that may be required.

It is a well-produced book, with 36 half-tone plates and a great many line illustrations, and anyone concerned with metal fabrication by welding, whether on the management or production side, should find it profitable reading.

Die-sinking and Engraving Machines. By H. C. Town, M.I.Mech.E., M.I.P.E., F.R.S.A. Brighton, 1960; The Machinery Publishing Company Limited. 5/- (by post 5/5). 72 pp. $5\frac{1}{2} \times 8\frac{1}{2}$ in.

Automatic duplicating has made many advances in recent years. The special machines which have superseded manual methods not only reduce production costs enormously, but have made possible the manufacture of the most complex components. This short work surveys the principal types of die-sinking and engraving machines in use to-day and in particular those electrically, electronically and hydraulically controlled, and the pantograph machines.

The section on electrical and electronic machines forms the main part of the book and the author proceeds from an account of general principles to an examination of a number of particular machines of various capacities, capable of making dies for motor car bodies or of machining moulds for ornamental glassware. The sections on hydraulic control and pantograph machines follow similar lines.

There are many excellent diagrams and the book should provide a useful introduction to the subject.

Basic Technical Electricity. By H. Cotton, M.B.E., D.Sc., M.I.E.E. London, 1960; Cleaver-Hume Press Limited. 12/6 net (by post 13/2). 246 pp. $5 \times 7\frac{1}{2}$ in.

This is the third edition of a work which first appeared in 1949 and has now been revised to include the M.R.S. system of units. It aims to provide a reliable grounding in the fundamentals of electricity for both the future engineer and the layman wishing to increase his basic knowledge.

Starting with the elementary facts of atomic structure and using the simplest language, Professor Cotton presents a complete survey of electrical theory and describes the uses of electricity and the construction of electrical machines. Only a minimum understanding of mathematics is required from the reader. There are 80 illustrations in line and half-tone.

Cutting Tools, Jigs and Fixtures. By H. C. Town, M.I.Mech.E., M.I.Prod.E. London 1960; Odhams Press Limited. 25/- net (by post 25/7). 248 pp. 9×6 in.

With the tendency today towards greater speeds in machine cutting, the author considers the use of the correct jigs as important as the choice of cutting tools. The book is therefore in two complementary sections, the first dealing with tool design, the second devoted to jigs and fixtures.

The theory of metal cutting is first of all explained. New and traditional cutting materials are surveyed and the methods of heat treatment and grinding set out. Then follow separate chapters on the various cutting tools in general use. In the second section the design and choice of jigs and fixtures are discussed and examples given of a wide range, including pneumatic and hydraulic devices.

As head of the engineering department at Keighley Technical College, the author has kept in mind the requirements of technical students and has included in each section a number of worked examples.

Fishing Boats of the World: 2. Edited by Jan-Olof Traung. London, 1960; Fishing News (Books) Limited. £7/7/0 (by post £7/9/6). 820 pp. $8\frac{1}{2} \times 11$ in.

This encyclopaedic volume of more than half-a-million words and over 800 illustrations and diagrams, is a record of the United Nations Food and Agricultural Organization's second World Fishing Boat Congress, held in Rome in April 1959, during which fifty odd papers were read and some 170 speakers contributed to the ensuing discussions. In four sections—tactics, boat construction, sea behaviour, and productivity—it covers from every angle the fishing craft of all the major countries engaged in sea fishing.

New materials and methods of boat construction naturally figure largely. One paper which caused considerable interest at the conference is by a United Kingdom delegate, Patrick D. De Laszlo, and deals with plastic hulls and decks made from cold setting polyester resin, reinforced with glass fibre "mat" laid up in a female mould. And, as fishing holds are such essential p. ts of fishing boats, there are papers on their architecture and construction, icing and freezing equipment and the merits of steam and diesel engines.

Fishing boat construction is probably more influenced by national traditions than any other industry and it is evident from the discussions here recorded how little the boat builders of any country know of their neighbours' methods. This book should help to remedy that situation.

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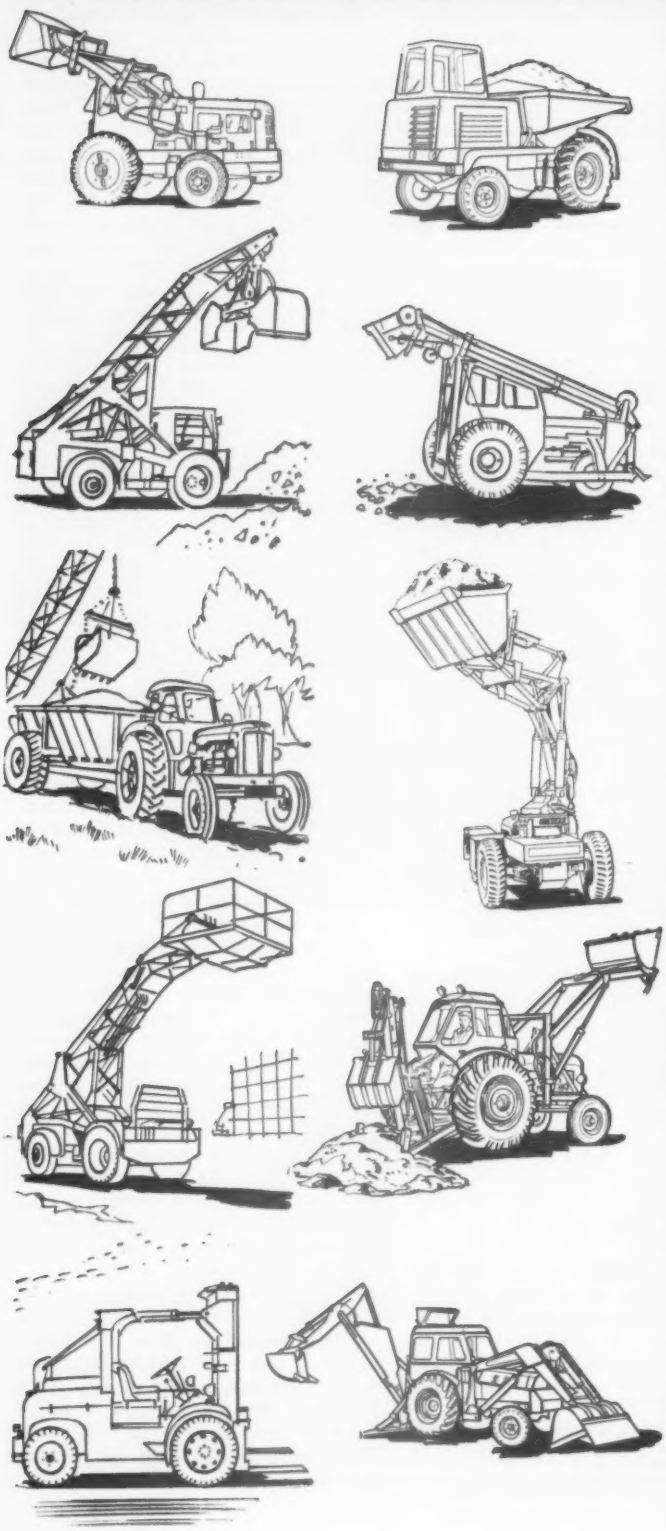

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Export Promotion.—Details of the ways in which industry can co-operate in Britain's overseas publicity are explained in a new edition of the Government's export promotion leaflets published by the Central Office of Information. These describe briefly the seven different services offered: press, photographs, films, publications, tours for foreign visitors, and distribution of publicity material. The leaflets can be obtained from The Controller (Overseas), Central Office of Information, Hercules Road, Westminster Bridge Road, London SE1.

Death Duties.—The effects of death duties on small manufacturing companies is examined in "The Scandal of Death Duties", a booklet issued by the National Union of Manufacturers, 6 Holborn Viaduct, London, EC1. This considers death duties to be illogical and absurd in many cases and calls for a Select Committee of Inquiry to examine the problem. In the meantime it believes that something should be done to ease the situation in which executors have to make a forced sale of a company's assets in order to pay death duties before legacies are settled and suggests a scheme of payment by instalments would be practicable.

The Older Worker.—With fifty per cent of the number of men in industry over forty years of age, it is important for our economic progress that there should be a proper understanding of the special problems of the older worker so that his skill and ability can be used to the best advantage. A popular and brief account of recent research in this field and in particular, of the studies reported in "Ageing and Human Skill" by A. T. Welford will be found in "The Older Worker and His Job" by Hilary M. Clay, No. 7, in the Problems of Progress in Industry series of booklets published by the Department of Scientific and Industrial Research. (H.M.S.O. Price 1/3).

Training Made Easier.—Although there have been a number of successful training schemes, industry as a whole has not shown much interest in developing systematic training methods. The problem, however, has not been neglected by human scientists and "Training Made Easier", a new booklet in the Problems of Progress in Industry series of the Department of Scientific and Industrial Research (H.M.S.O., 2/–) contains four recent studies particularly relevant to training for manual operations. Although offering no ready-made techniques they indicate the rethinking necessary before a training scheme can be organized and will stimulate managements to examine their present training methods and see how they can be improved.

European Economy.—The United Nations Economic Survey of Europe for 1959 is the thirteenth in a series of reports prepared by the secretariat of the Economic Commission for Europe to help in the task of reporting on world economic conditions. It is in four parts. The first part is the annual analyses of recent developments in the European economy; Part II is devoted to the new long-term plans of East European countries; Part III deals with the size and scope of the public sector in the more highly industrialized economies of Western Europe; and in Part IV an attempt is made to review the past course of agricultural and industrial development in five Southern European countries and Ireland and to discuss some of their problems. The survey can be obtained from H.M. Stationery Office, P.O. Box 569, London SE1, price 21/-.

New Standards

Valves for the Petroleum Industry. B.S. 1414, Price 15/-; B.S. 1570, Price 15/-; B.S. 1735, Price 12/6; B.S. 1868, Price 15/-; B.S. 1873, Price 15/-.

The above five 'key' standards for valves for the petroleum industry have been revised. They specify ratings, design, materials, dimensions, tests and marking requirements for the following types of valves:

B.S. 1414: cast or forged steel rising-stem, outside screw-and-yoke solid wedge gate valves with internal flanges and with butt-welding ends. The Classes are: 150, 300, 400, 600, 900, 1500 and 2500. Nominal sizes: 1 in. to 24 in.

B.S. 1570: cast or forged steel lubricated and non-lubricated plug valves having straight-way ports, with integral flanges and butt-welding ends. The Classes are 150, 300, 400, 600, 900, 1500 and 2500. Nominal sizes 1 in. to 24 in.

B.S. 1735: Flanged cast iron valves of the wedge gate and double disk gate types, with either outside-screw-and-yoke, rising-stem, or inside-screw, non-rising-stem. The Classes are: 125 and 250. Nominal sizes: $1\frac{1}{2}$ in. to 24 in.

B.S. 1868: cast or forged steel check valves of the swing piston and ball types. The Classes are: 150, 300, 400, 600, 900, 1500 and 2500. Nominal sizes: 1 in. to 18 in.

B.S. 1873: cast or forged steel outside-screw-and-yoke type globe valves with internal flanges and with ball or plug type disks. The Classes are: 150, 300, 400, 600, 900 and 1500. Nominal sizes $\frac{3}{4}$ in. to 8 in.

Aluminium Alloy Conductors for Overhead Power Transmission. (B.S. 3242: 1960). Price 4/6.

The requirements in this new standard are similar to those of B.S. 215 (which deals with aluminium and steel-cored aluminium conductors) but the new standard covers a range of stranded conductors made of heat-treated aluminium-magnesium-silicon alloy in sizes from 0·015 sq in. to 0·4 sq in. copper equivalent.

Methods of Determination of Resistivity of Metallic Electrical Conductor Materials (B.S. 3239: 1960). Price 5/-.

This new standard prescribes the methods of determining resistance and resistivity to be used in reference and routine tests on metallic conductor materials. The accuracy of the reference method is as high as can be expected under laboratory conditions, and that of the routine method sufficient for most practical purposes. It is intended that the reference method should be used in any case of dispute. An appendix to the 20-page standard explains the use of various temperature coefficients of resistance and resistivity.

Solid Drawn Steel Air Receivers not intended for Transport (B.S. 430: 1960). Price 3/-.

This revision of the 1944 edition of B.S. 430 now permits the use of steel of 26 to 48 ton/sq in. tensile strength range. It applies to solid drawn steel air receivers intended to contain air or inert gas above atmospheric pressure—*not* to receivers manufactured of alloy steels. Other differences between this and the previous edition are that the maximum sulphur and phosphorus content of the steel has been limited and the requirements for the rate of testing the steel have been clarified.

British Standards Institution, 2 Park Street, London W1.

BUSINESS & PROFESSIONAL

Personal

THE Council of the Royal Society has appointed **Dr. D. T. Edmonds,** of the Clarendon Laboratory, University of Oxford, to a Mackinnon Research Studentship from October 1, 1960 to enable him to carry out magnetic investigation below 1° K in large magnetic fields at the Clarendon Laboratory, Oxford.

The Committee representing the Royal Society and the Armourers and Brasiers' Company has appointed **Dr. J. H. Brunton,** to the Armourers and Brasiers' Research Fellowship from October 1, 1960 to work on deformation characteristics of base metals at very high rates of strain at the Laboratory for the Physics and Chemistry of Solids, Cavendish Laboratory, Cambridge.

Included in the awards of grants by the Paul Instrument Fund Committee is that of £500, in supplement of a previous grant, to **Dr. H. Motz,** Donald Pollock reader in engineering science, University of Oxford, for the construction of a linear accelerator working at 1·6 cm (J-band).

ASSOCIATED ELECTRICAL INDUSTRIES Limited. *Heavy Plant Division:* **Mr. R. R. Huitson, M.I.Mech.E.,** has been appointed consultant to the division and will undertake special duties in connexion with the promotion of A.E.I. business in centrifugal compressors and allied apparatus. **Mr. T. E. Adams, B.Sc.(Eng.),** previously chief engineer, Nuclear Auxiliaries Department, A.E.I. Turbine-Generator Division, is appointed manager of the compressor engineering department, A.E.I. Heavy Plant Division.

Mr. George Baker, of Turbine Factory, A.E.I. Rugby Works, has been awarded the B.E.M. (British Empire Medal) in the Queen's Birthday Honours List.

A.E.I. ELECTRONIC APPARATUS DIVISION announce the appointment of **Dr. J. M. Westhead** as manager, Valve & Semiconductor Sales Department, Lincoln, to succeed **Mr. F. Baxendale** who will remain as consultant. Dr. Westhead has been deputy manager of the department since April 1 this year.

Mr. A. C. Copisarow, at present Scientific Attaché at Paris will take up the post of director of the Forest Products Research Laboratory on the retirement of **Dr. F. Y. Henderson, C.B.E.,** in October next.

Mr. W. E. A. Redfern has resigned as chairman of the Alloy Steel Association and is succeeded by **Mr. R. Bavister.**

UNION CARBIDE ALLOYS DIVISION announce that **Mr. M. A. Clifton** has joined the outside sales staff as a representative in the southern area, and will be based on the head office in London.

Mr. G. A. Jones has been appointed manager of the contract supervision and installation department, Honeywell Controls Limited.

Mr. H. A. Andrews has been appointed general manager of Power Auxiliaries Limited, member company of The Plessey Group specializing in the manufacture of seamless flexible, metallic hose widely used in the aircraft, nuclear and marine industries.

THE industrial division of Wakefield-Dick Industrial Oils Limited, a member of the Castrol Group of Companies, have appointed **Mr. P. H. Cripps** as their regional sales manager for London and the Home Counties.

BRITISH RAILWAYS (SCOTTISH REGION) have appointed **Mr. H. O. Baldwin,** former assistant signal engineer, Scotland, as signal engineer, Scotland.

Mr. L. P. Simpson, works manager of Baker Perkins Limited, of Peterborough, has been appointed a director.

Mr. Matthew Reid Moore, who became general sales manager of Richard Sutcliffe Limited, Horbury, Wakefield, earlier this year, has now been promoted to the position of general manager.

THE UNITED STEEL COMPANIES LIMITED announce that **Mr. S. N. Kinsley,** deputy secretary of United Steel research and development department succeeded **Mr. Geo. H. Davison** as secretary of the department on the latter's retirement on June 30. Mr. Davison, who has been with the company for 27 years, will continue to serve in a full-time advisory capacity for the time being. Appleby-Frodingham Steel Company: **Mr. R. Wogin,** formerly manager of the Appleby melting shop has been appointed assistant works manager (steel). **Mr. R. Johnson** has been appointed melting shops manager, responsible for both the Appleby and Frodingham melting shops, together with the basic slag plant and the refractories section. **Mr. A. F. Jessop** has been appointed manager of the Appleby melting shop and **Mr. W. L. Willsher** becomes manager of the Frodingham melting shop. Steel, Peech and Tozer: **Mr. Andrew Jollie** is resigning from his position as director and general manager and is succeeded by **Mr. T. S. Kilpatrick,** former director and general manager of Workington Iron and Steel Company. **Mr. R. Waller** has been appointed mechanical maintenance superintendent in succession to **Mr. A. Stark,** who has retired after 22 years' service. Distington Engineering Company Limited; **Mr. T. Wintrup,** sales manager (engineering) has been appointed purchasing and contracts manager. **Mr. J. Tonks,** senior draughtsman, succeeds Mr. Wintrup as sales manager (engineering). **Mr. Gail Stifler** has been appointed sales manager, European Operations, of the Clearing division of U.S. Industries Inc., and will operate from the company's European office in London. **Mr. Desmond R. Stanley-Adams** has been appointed export sales manager of the International Division of U.S. Industries Inc. He will cover Europe and the Middle East for this organization which acquired the Burtonwood Engineering Company, Lancashire, last October.

CIBA (A.R.L.) LIMITED announce the resignation of **Dr. N. A. de Bruyne** from the position of managing director at the end of 1960. He will, however, remain on the Board. On and after January 1, 1961, **Mr. R. F. G. Lea, O.B.E., M.A.,** will become deputy chairman of the company. **Mr. R. F. G. Lea** and **Mr. D. A. Hubbard** will also become joint managing directors.

F. PERKINS LIMITED, following the return from Brazil of Mr. M. I. Prichard, managing director, and the expansion of Perkins interests in the rapidly-growing diesel market throughout South America, have announced the following new appointments: **Mr. F. J. W. Holt,** managing director of Motores Perkins S.A., F. Perkins Limited's associate company in Sao Paulo, Brazil, has been appointed resident representative for the Perkins Group in South America. **Dr. Manuel Garcia Filho,** previously commercial director of Motores Perkins S.A., is appointed managing director (director superintendente) and in this capacity will be responsible for the administration of the Brazilian company. He will be supported by **Mr. Charles F. Hill,** appointed to the board of directors as deputy managing director (director gerente) responsible for factory management.

BOWMAKER (PLANT) LIMITED announce the appointment of **Mr. Douglas B. Speight** to the new post of earthmoving representative. **Mr. J. W. C. Hart** has taken over the Shropshire and North Staffordshire territory.

Major-General Sir Francis de Guingand, K.B.E., C.B., D.S.O., and **Mr. T. J. Boulstridge** have been appointed to the board of Raleigh Industries Limited.

Mr. B. S. Freeland has been transferred to the staff of the chief engineer (sales) of Tufnol Limited for special duties in the market research unit. Mr. Freeland, who was London area branch manager for Tufnol Limited from 1935 is succeeded by his former deputy, **Mr. F. J. Griggs,** who has served with the company for 28 years.

Which of these five is the best?

STAG MAJOR (10-12% Co. 21% W)

STAG SPECIAL (18% W)

STAG EXTRA SPECIAL (6% Co. 18% W)

STAG AIR-HARDENING (15% W)

STAG M.O. 562 (5% MO.)

Each one of these five
Stag high speed steels is the best!
— the best of its kind

Which of them is the best *for your job* depends upon the work you call on them to do.
"Stag Major" with its very high content of expensive alloying elements, will of all high speed steels stand up to the hardest tasks, but it would be needlessly costly for less exacting jobs which could more economically use "Stag Special" or Stag "MO.562".
And, of course, the converse applies!
To enable you to get the best investment from your high speed steels, we will send you our booklet "STAG HIGH SPEED STEEL" which contains full information on usage and treatment of these five high grade steels.

EDGAR ALLEN

'STAG' HIGH SPEED STEELS

EDGAR ALLEN & CO. LIMITED
IMPERIAL STEEL WORKS, SHEFFIELD 9

TS33/MW

To **EDGAR ALLEN & CO. LTD., SHEFFIELD 9**

Please send data on HIGH SPEED STEELS to:

Name .....

Position .....

Firm .....

Address .....

Mr. S. H. Bailey, who has been publicity manager for the company since 1934, has retired after 46 years' service, and is succeeded by **Mr. David I. Herbert.**

AFTER 23 years as manager of the machinery department (southern area) of Thos. W. Ward Limited, **Mr. W. S. Cliffe** has now retired. He began his career in the company's head office at Sheffield in 1913. He continues to serve in an advisory capacity until December 31 and is succeeded in his appointment by **Mr. C. R. Harkcom,** another old servant of Ward's and formerly general manager of their Indian company in Bombay.

JOHN BASS LIMITED, of Crawley, Sussex, announce the appointment to the board, of the following directors: **Mr. E. J. Granger, A.M.I.Mech.I., A.M.I.Prod.E.,** and **Mr. J. W. Reynolds.**

CATMUR MACHINE TOOL CORPORATION Limited announce that **Mr. N. W. S. Catmur** having reached retirement age, relinquished his position as managing director of the company on July 31. He is however, remaining with the company as deputy to the chairman, **Sir Wm. Palmer, K.B.E., C.B. Mr. Peter S. Catmur,** who was appointed a director of the company in 1956 has assumed the the position of managing director.

THE DOWTY GROUP announce the appointment of **Mr. Lionel Harper** as managing director of Dowty Hydraulic Units Limited. Mr. Harper was formerly managing director of Massey-Ferguson (Great Britain) Limited.

THE following appointments are announced by Firth Cleveland Steel Strip Limited, Locarno Road, Tipton, Staffs., a member of the Firth Cleveland Group: **Mr. K. A. Smith** has been appointed to the full board as production director. **Mr. D. R. Moylan** (Contracts Manager) and **Mr. C. D. Gladwin** (chief inspector and metallurgist) have been appointed executive directors. **Mr. G. F. Wright** has been appointed assistant contracts manager, and **Mr. A. J. Braddock** assistant works manager. **Mr. E. F. Ellis** is sales manager, Midlands and South West area. The export Sales Department is now under **Miss D. Groom. Mr. H. Terry** has replaced **Mr. E. J. Andrews** as purchasing officer. Mr. Andrews is now Midlands sales representative. **Mr. H. J. Hyett** has been appointed personal assistant to Mr. E. W. Day, sales director.

BRITISH INSULATED CALLENDER'S CABLES Limited have appointed **Mr. B. Hollingworth, A.M.I.E.E.,** to the position of assistant sales manager (mining) in succession to **Mr. J. A. Rodgers,** who is now divisional sales manager (accessories).

ACHESON DISPERSED PIGMENTS COMPANY (Division of Acheson Industries (Europe) Limited), have made the following new appointments and promotions. **Mr. B. R. Corry, A.R.I.C.,** has been transferred from another unit of the Acheson Organization and promoted to works chemist. **Mr. T. H. Stothard, F.R.I.C.,** has been appointed works manager. **Mr. K. Harwood** has been promoted to the new position of production supervisor. **Mr. K. Clark,** for several years a senior technical representative with Acheson Colloids Limited, is wholly engaged on ADP sales development.

Mr. S. A. Roberts, managing director of the BSA Tools Division has been appointed a director of The Birmingham Small Arms Company Limited, the parent company of the BSA Group.

W. & T. AVERY LIMITED, Birmingham, announce the appointment of **Mr. R. C. Hale** as director and commercial manager.

Mr. A. Stephens has rejoined Honeywell Controls Limited as senior flow engineer at the company's Greenford (Middlesex) head office, and **Mr. R. W. H. Vivian** has been appointed to specialize on application engineering using the company's electric miniature instrumentation. Mr. Vivian will shortly leave this country for a brief study of United States experience in this field.

Obituary

WE regret to record the death of **Mr. F. C. Archer,** superintendent of The General Electric Company Limited winding department. He was 62 years of age and joined the company in 1937.

Addresses

EVERSHED & VIGNOLES are now directly represented in Birmingham by a new branch office at 58 Oxford Street, Birmingham 5, which will cover Derbyshire, Leicestershire, Shropshire, Nottinghamshire, Staffordshire, Warwickshire and Worcestershire. Management of this office will be under Mr. E. R. O'Dell.

YATES PLANT, specialists in mechanized welding shop plant, have now moved their design, development and sales sections from London to Bedewell Works, Hebburn-on-Tyne, where all their equipment is manufactured. Accordingly their address from August 1 is Yates Plant Limited, Bedewell Works, Hebburn-on-Tyne, Co. Durham.

A NEW division has been created by the BSA company to handle its agricultural and industrial engine business. The address is—The Birmingham Small Arms Company Limited, Power Unit Division, Studley Road, Redditch, Worcs. The manager of the new plant is Mr. H. V. Gray and the sales manager Mr. G. R. Turner. After-sales service and spare parts will be dealt with from the BSA Service Department, Waverley Works, Coventry Road, Birmingham 11.

BRITISH INSULATED CALLENDER'S CABLES Limited, now have a new West London depot at Silverdale Road, Hayes, Middlesex (Telephone Hayes 8241). This depot will carry a comprehensive stock of rubber, thermoplastic and mineral insulated cables and accessories. Mr. T. W. Hills will be in charge.

THE OFFICE MANAGEMENT ASSOCIATION, founded in 1915, has now changed its name to "The Institute of Office Management", a prelude to a big programme aimed at improving the standard of office efficiency in the United Kingdom. Further information is available from the secretary of the Institute of Office Management, 56 Victoria Street, London SW1, (Victoria 3216).

THE Manchester sales office of Richard Hill Limited, Middlesbrough, a member of the Firth Cleveland Group, has been moved from Spring Gardens, Manchester, to a new building at 19B School Road, Sale, Cheshire. A reinforced concrete design office is to be opened at the same address, under the supervision of Mr. D. H. Halstead, A.M.I.Struct.E., as chief engineer.

A NEW company, Hird-Brown Limited, with headquarters at 244 Marsland Road, Sale, Cheshire, has been formed to design and manufacture photo-electric controls. The company has absorbed the entire activities of Paton Brothers Engineering Services, formerly carried out at the same address and at 15 St. James Row, Sheffield. The joint managing directors are Mr. T. Bryan Hird, and Mr. Roy Brown, both formerly of Metropolitan-Vickers Electrical Company Limited.

THE head office of Rhodes, Brydon & Youatt Limited has been moved from the company's old premises at Waterloo Engineering Works to their new works at Reddish. All correspondence should be addressed to Reddish Engineering Works, Stockport, Cheshire. The telephone number is HEAton Moor 6211 (6 lines).

ALFRED BULLOWS & SONS LIMITED, Long Street, Walsall, Staffs announce that they have established a subsidiary company in Australia, under the management of Mr. W. J. Proffitt, known as Alfred Bullows & Sons (Aust) Pty. Limited, Ethel Avenue Brookvale, Sydney, N.S.W.

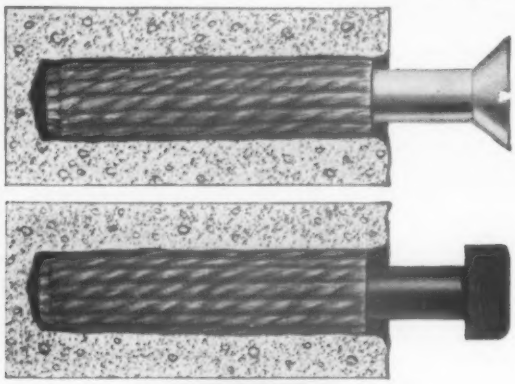
———*Addendum*

Nuclear Research and Power Reactors in Euratom Countries

To the names of countries who are members of European Communities and Agencies (listed in Table XIV, p. 199 of our May issue) there should be added that of Spain, which is a member of O.E.E.C., Eurochemic, and E.N.E.A.

SCREW-FIXING IS FASTER THAN EVER!

'Rawlplugs are by far the speediest method of screw-fixing in the world'—you've known that for years. But have you noticed how much faster even Rawlplugs are today, with the sensational Rawlplug drills and power tools now available for drilling the holes in all kinds of masonry? It's well worth looking into!



RAWLPLUGS

FOR ALL SCREW SIZES

There's a Rawlplug for every size of screw up to ¾″ diameter coach screws, which take a load of 4 tons.

Rawlplugs are the fixing for *neatness* as well as speed and strength—no mess, no damage to surrounding materials, almost invisible in position. Being rotproofed and waterproofed during manufacture, they can be used under all climatic conditions. Screws can be withdrawn and replaced without affecting the efficiency of the Rawlplugs.

Write now for illustrated literature containing full details of Rawlplug Fixing Devices and the many high performance Rawlplug tools (hand, electric and pneumatic).

THE RAWLPLUG CO. LTD.,
CROMWELL ROAD, LONDON, S.W.7

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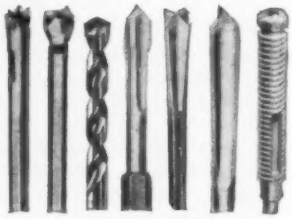
The world's largest manufacturers of fixing devices

B433A

HIGH EFFICIENCY BORING TOOLS AND DRILLS

For cutting holes in any material—concrete to glass—Rawlplug tools are the speediest, most efficient and durable in the world. Sizes and types to meet every need—hand, electric or air power. Among hand percussion tools are Rawldrills, Stardrills, Tubular and Wall Boring Tools. For hand or power—Durium, the world's fastest masonry drill, and Durium Glass Drills. Power only—Vibroto, Rawlcrete, Durium Hammer Drills, etc.



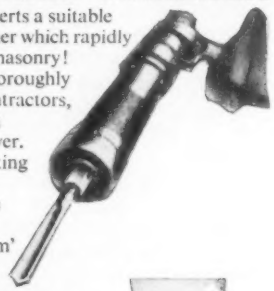
R.P.2 *Two-speed* ELECTRIC DRILL

Keyless Chuck

At the touch of a button you can change the speed of this drill from 1200 r.p.m. to 420 r.p.m. which is the ideal speed for Durium Masonry Drills. Chuck capacity is 5/16″. Finger tightening holds the smallest drill in rigid grip which increases with the load yet can be easily released.

RAWLPLUG DRILL HAMMER

This ingenious attachment converts a suitable electric drill into a Power Hammer which rapidly bores holes in even the hardest masonry! A sturdy high-precision tool, thoroughly proved and used by famous Contractors, the Rawlplug Drill Hammer is a magnificent time-and-money saver. Suits any electric drill with working speed up to 2000 r.p.m. and minimum ¼″ chuck. Speed—one blow per chuck rev. Weight of blows adjustable 'light', 'medium' and 'heavy'.



Rawlplug VIBROTO Drilling Machine

The performance of this sensational 3 in 1 power tool must be seen to be believed—three high-precision machines in one! The Vibroto R.V.1 machine provides (1) dual vibration action (with Vibroto Drills, faster masonry drilling even than Durium!); (2) Rotary action for standard Durium Drills; (3) general purpose tool for use with standard twist drills. Vibration frequencies 7,500 and 11,200 per minute. Weight 9 lb. Length overall 18½″. Fully guaranteed. The R.V.2 machine is a smaller version and although lighter in weight it has all the advantages of the R.V.1 for drilling holes in masonry up to No. 14 using Vibroto hard-tipped drills.

RAWLPLUGS

Contracts and Work in Progress

THE ENGLISH ELECTRIC COMPANY LIMITED.—A 400 MVA transformer for C.E.G.B. High Marnham power station. Costing about £250,000 the transformer will be one of the two biggest ever made in the U.K.

£500,000 contract from James Booth Aluminium Limited, Birmingham for rolling mill electrical equipment.

ASSOCIATED ELECTRICAL INDUSTRIES Limited.—Telephone equipment valued at £500,000 for the Australian Post Office. *Heavy Plant Division:* 5000 hp d.c. motor and auxiliary drives for Samuel Fox & Co. Limited. Rolling mill drives valued at £¾M. for Samuel Fox & Co. Limited, Head Wrightson Machine Company Limited, and South Durham Steel and Iron Company Limited. *Motor and Control Gear Division:* Contracts valued at £317,000 for heavy duty crane drives for installation at the Spencer Works (Newport, Mon.) of Richard Thomas and Baldwins Limited.

PRODUCTION-ENGINEERING LIMITED.—Appointment as co-ordinating consultants for the new Milan plant of Alfa-Romeo estimated to cost about £50M.

ELLIOTT-AUTOMATION LIMITED.—£90,000 order for automatic control equipment for a new zinc smelting plant to be erected at Noyelles-Godault in northern France placed with the Industrial Weighing Division of Elliott Brothers (London) Limited.

BRUSH ELECTRICAL ENGINEERING COMPANY Limited. (Hawker Siddeley Group).—Power equipments for 66 Type 4 diesel electric locomotives for British Railways.

TUBE INVESTMENTS LIMITED.—Orders for X-ray scanning microanalyser (produced in collaboration with the Cavendish Laboratory, Cambridge) manufactured by Cambridge Instrument Company, received from home and overseas.

WILLIAM BOBY & COMPANY LIMITED.—Contract valued at more than £20,000 from Courtaulds Limited for the extension of their Courtelle plant at Grimsby.

Contract value £5,691 awarded by South of Scotland Electricity Board for demineralization plant for Braehead Power Station.

£8,500 contract for lime-soda plant for the Distillers Company Limited.

£40,000 contract for five deaerators for Richard Thomas & Baldwin Limited's Spencer Works, awarded by Parolle Electrical Plant Company Limited.

BRITISH OXYGEN GASES LIMITED.—Contract from The Steel Company of Wales Limited to build and operate the biggest tonnage oxygen plant in the Western Europe iron and steel industry to be installed at Margam Works. Value over £1M.

INTERNATIONAL COMPUTERS & TABULATORS Limited.—Twelve orders from Australia, Sweden, and the U.K. for the new business computer Type 1301 data processing unit. Value more than £1M.

Order worth £337,792 for punched-card machines for General Post Office.

GORDON FELBER & COMPANY LIMITED.—Orders from Australia and Italy for 1100 Mayrath screw conveyors.

THE SCOTTISH MACHINE TOOL CORPORATION Limited.—Order from British Railways Scottish Region for reconditioning of Loudon wheel lathe, Cowlairs Works.

WILLIAM BAIN & CO. LIMITED.—Contract for supply of fabricated structural steelwork for the Ras Abu Aboud Power Station, Doha, Qatar, Arabian Gulf. Value over £43,000.

CLYDE CRANE & BOOTH LIMITED.—Order for 10 level-luffing cargo handling dockside cranes for Tees Dock, Tees Conservancy Commissioners.

MASSEY-FERGUSON.—£3¼M. order from Yugoslavia for tractors and farm implements.

BRITISH INSULATED CALLENDER'S CABLES Limited.—Indian railway contract value £1,200,000 for supply and installation of overhead equipment.

BROOKHIRST IGRANIC (M.I. Group).—Order worth over £100,000 for further 23 sets of electrical controls for cranes at the Spencer Works of Richard Thomas and Baldwins.

FAWCETT PRESTON (M.I. Group).—Order from Brush Electrical Engineering Company for over 100 sets of locomotive resistors.

DAVID BROWN AUTOMOBILE GEARBOX Division.—£100,000 contract covering long-term supply of truck gearboxes for leading British commercial vehicle builder.

DOWDING & DOLL LIMITED.—Further U.S.S.R. order value £50,000 for Universal gear hobbing machines.

E.M.I. ELECTRONICS LIMITED.—Further order from Short Brothers & Harland Limited for vertical milling machine fitted with E.M.I. electronic control system.

E.M.I./Wadkin electronically controlled drilling machine for Priestmans Limited, Hull.

HEENAN & FROUDE LIMITED.—Jet engine thrust cradle for testing Bristol-Siddeley Viper engines manufactured under licence by Piaggio of Italy.

Hydraulic dynamometer, 20,000 hp, for Pula, Yugoslavia.

Two Heenan-Dynamatic dynamometers for International Harvester Company of Australia Pty. Ltd.

EKCO ELECTRONICS LIMITED.—Order from C.E.G.B. for 86 radiation monitors.

HONEYWELL CONTROLS LIMITED.—C.E.G.B. order for 80 circular scale indicators to measure system frequency.

Business Developments

Company acquisitions

BAKER PERKINS LIMITED have acquired the Granbull Tool Company Limited of Kingston on Thames and Twickenham.

THE acquisition is also announced of Rownson (Conveyors) Limited of Yorks Way, London N7.

HAMWORTHY ENGINEERING LIMITED have purchased Schieldrop and Company of Stotfold, Beds., manufacturers of industrial oil burning equipment for kilns and furnaces.

GRIFFIN & GEORGE LIMITED have purchased the whole share capital of R. & J. Beck Limited, optical instrument manufacturers.

THE merger of the Cambridge Instrument Company Limited and Electronic Instruments Limited of Richmond has been announced by the Cambridge Instrument Company's acquisition of the whole of the ordinary share capital of Electronic Instruments Limited.

VICKERS LIMITED, London and Herr Hans J. Zimmer of Frankfurt am Main, have formed a joint enterprise for industrial plant construction—Hans J. Zimmer Aktiengesellschaft Fuer Industrieanlagenbau.

Agents and distributors

BRAY CONSTRUCTION EQUIPMENT LIMITED, Feltham, Middlesex, have appointed William R. Selwood Limited, Chandler's Ford, near Winchester, Hants., sole agents in Hampshire, Wiltshire, Dorset, Somerset and Berkshire for their hydraulic loading shovels.

COOK & NICHOLSON LIMITED of Wear File Works, Sunderland, have been appointed agents for North-East England by Weldcraft Limited of Slough (one of the G. D. Peters group).

MR. C. A. ABRAHAMS of 71 Thames Village, Hartington Road, London W4 is sole agent for the U.K. and other Commonwealth countries for the sale of the laminated spring regenerating machine perfected by Ateliers de Menpenti, Marseille.

Trading agreements

HAMWORTHY ENGINEERING LIMITED of Poole have granted a licence to build Hamworthy type air compressors to Soc. des Chantiers et Ateliers de Provence, Marseille. The machines will be available in France and territories through Etablissements Tiano, 2bis, Rue de la Baume, Paris 8e.

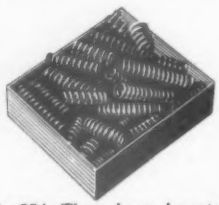
THE TELEGRAPH CONDENSER COMPANY Limited of the United Kingdom, and Sprague Electric Company, of the U.S.A. have made a reciprocal agreement concerning patents, applications and developments of the products of both companies.

THAT *Experimental Spring* YOU WANT IS WAITING FOR YOU IN THIS BOX ...

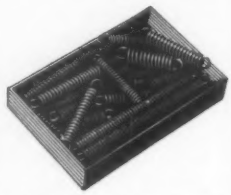
No. 1217. One gross Assorted Springs. A complete Garage Service Kit. 42/- each.

If not, try another box in the Terry Assorted Springs range

No. 1200. Three dozen Assorted Light Expansion Springs, suitable for carburettor control, etc. **13/6.**

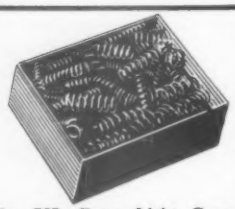


No. 98A. Three dozen Assorted 1″ to 4″ long, ¼″ to ⅜″ diam., 19G to 15G. **5/6.**



No. 753. Three dozen Assorted Light Expansion ¼″ to ½″ diam., 2″ to 6″ long, 22 to 18 S.W.G. **10/6.**

No. 760. Three dozen Assorted Light Compression Springs. 1″ to 4″ long, 22 to 18 S.W.G., ¼″ to ½″ diam. **6/6.**



No. 757. Extra Light Compression, 1 gross Assorted, ⅛″ to ⅜″ diam., ½″ to 2½″ long, 27 to 19 S.W.G. **15/-.**

No. 758. Fine Expansion Springs. 1 gross Assorted ⅛″ to ⅜″ diam., ½″ to 2″ long, 27 to 20 S.W.G. **15/-.**

We know *exactly* how difficult it is to find springs for experimental work . . . we've been making quality springs for over 100 years. So, we confidently offer you our excellent range of small boxed assortments which covers a very wide range.
We can only show a *few* boxes.
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Redditch, Worcs.

(*Makers of Quality Springs, Wireforms and Presswork for over 100 years*)

HT30

Rocol Lubricants

In half a decade Rocol Limited, Swillington, near Leeds, has become known throughout the world as manufacturer and supplier of specialized lubricants and molybdenized lubricants in particular. The lead for Britain in this field was the result of ten years of research and development, interrupted by the war, into the properties and uses of molybdenum disulphide and its incorporation into various vehicles for its application: some of the vehicles are greases devised and developed by Rocol only. To celebrate the five expanding years, Rocol have produced a well illustrated booklet entitled "ROCOL—First in Molybdenum Disulphide Lubrication". "When it is realized", says the booklet, "that such well accepted terms as 'Anti-Scuffing Paste' and 'Molybdenized Lubricant' were first used by Rocol, the pioneering nature of its early activities can be realized". The booklet shows how molybdenum disulphide is purified and prepared, the results of some of the tests on various types of equipment, and describes its salient properties. There follow three pages of tables indicating the many Rocol lubricants, the methods of applying them, their general uses and temperature and pressure ranges. Eight pages of photographs show a great diversity of application.

Fluorescent Lighting Fittings

The "Stripline" range of fluorescent batten fittings is designed for use with the standard 5 ft 80-watt "Stripline" batten, which can be simply converted into a 2-light batten, a reflector fitting, or used in the form of continuous runs. The basic metal channel, with short or long backplate has easily removable end caps and, by the addition or replacement of a few basic parts, a wide range of fluorescent fittings is available. These include reflector attachments, plastic diffusers, and louvres and can be supplied to customers' special requirements. A leaflet is available from the makers, Courtney Pope (Electrical) Limited, Amhurst Park Works, Tottenham, London N15.

Motorspeed Control

Class 50,000 "Variac" d.c. motor speed controls are simple devices that provide adjustable-speed operation of d.c. motors from the standard a.c. mains, thus combining the convenience of a.c. power supply with the good starting characteristics and regulation of d.c. shunt- or compound-wound motors. The necessary rectifiers are selenium types and no electronic valves are used so there is no time delay in starting. The controls are made in a wide range of models from $\frac{1}{15}$ hp to $1\frac{1}{2}$ hp. The makers, Claude Lyons Limited, Valley Works, Hoddesdon, Herts., can supply a leaflet.

Stellite for Jigs and Fixtures

The life of jigs and fixtures can be multiplied with constantly maintained accuracy by the incorporation of Stellite alloy at the weaving places. The alloy is either deposited or applied solid by brazing. How this is done in some typical examples is clearly shown in the latest technical publication, SP21, issued by Deloro Stellite Limited, Highlands Road, Shirley, Solihull, Warwickshire.

Japanese Ship Machinery

The major position in the world held by Japanese shipbuilding has been accompanied by the rise of an equally large marine engine building industry. Diesel engines, steam turbines and boilers of all sizes, deck machinery, pumps and valves, anchors and chains, and all descriptions of auxiliary machinery and mechanical and electrical fittings. Descriptions, particulars and illustrations of all the various Japanese manufacturers' products have been collected into one large, cloth bound catalogue which is issued by The Ship Machinery Manufacturers' Association of Japan, 2 Kanda Tsukasa-cho, 2-chome, Chiyoda-ku, Tokyo.

Trade Literature

Readers interested in any of the catalogues reviewed here can obtain copies by mentioning* MECHANICAL WORLD *when writing to the firms concerned.

Self-cleaning Filters and Scrubber

Dealing with a piece of equipment new to this country is Publication No. 51 from Keith Blackman Limited which illustrates and describes the Tornado-Fischer automatic self-cleaning filter. Its efficiency in handling dust particles of virtually all sizes rests on the special design of the filter elements, the type of filter fabric and the patented cleaning mechanism. Negligible maintenance is required. Folder No. 8 from the same company briefly describes another unit, the Tornado-Solivore wet scrubber, Vicard process (patented) for collecting fine dusts and fumes down to 0·1 micron dia or even smaller. Each of these folders is available on application to Keith Blackman Limited, Mill Mead Road, London N17.

Rigidex Polyethylene

Technical Information Sheet No. 10 available on request from British Resin Products Limited, Devonshire House, Piccadilly, London W1, details the characteristics and properties of three new types of Rigidex high density polyethylene. They are designed for use where high resistance to stress cracking and superior load bearing properties are required.

Assembly Trays and Storage Bins

"Kabi" trays and bins in various sizes and shapes which can be built up into assembly units to suit any purpose are described in a new folder from Precision Components (Barnet) Limited, 13 Byng Road, Barnet, Herts. A folder describes "Plastibox" storage trays which will form storage banks of any height or length in the stores merely by stacking them together or, for the production line, by hooking them to a rail. All the items are made from Alkathene, the I.C.I. brand of polythene.

"Aeromatic" Hammer Gear

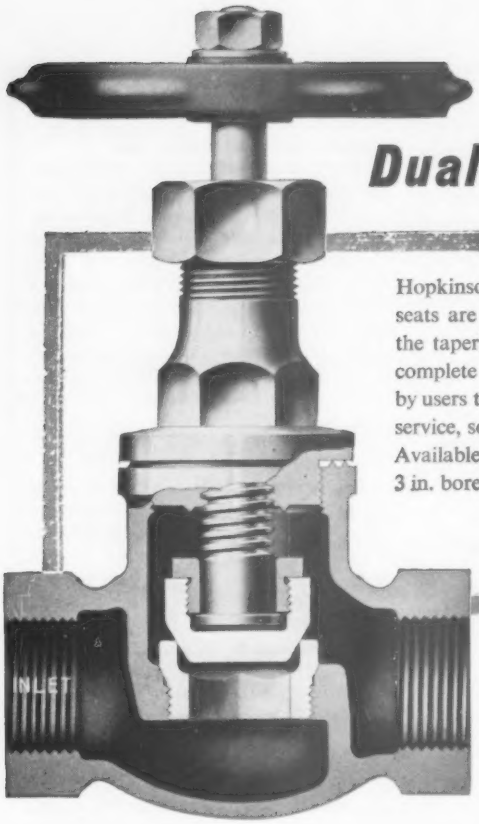
The Aeromatic gear is a new system of drop hammer control which combines easy and sensitive operation with ability to strike heavy and light blows of predetermined energy. It is normally fitted to new Massey Marathon and self-contained friction drop-hammers and can in many cases be added to existing hammers. Full particulars and illustrations are given in a new folder available from B. & S. Massey Limited, Openshaw, Manchester.

Thermometer Regulators and Pyrometer

A range of thermometer regulators available from stock is described in List 176 issued by the Cambridge Instrument Company Limited. These control accurately and reliably a great number of processes which are either heated or cooled by gas or electricity and bring automation control to boilers, refrigerating and ventilation plant, furnaces, ovens, etc. The ranges available include all temperatures from −10° to 100° F and 0° to 600° C. List 304/1 describes the Cambridge needle pyrometer which consists of a light portable indicator which will pentrate below the surface of materials such as rubber and plastic to provide rapid and accurate temperature readings. These lists are available from the Cambridge Instrument Company Limited, 13 Grosvenor Place, London SW1.

World Screw Thread Standards

"The Robertson Guide to World Screw Thread Standard" is the latest in a series of technical guides published by W. H. A. Robertson & Company Limited, Lynton Works, Bedford. This collates in one volume the screw thread standards of the world and gives them a common denominator of comparison. Over 2000 standards are listed from the 33 countries publishing their own national standards and 108 screw thread forms are illustrated together with self-tapping screws. The guide, which is priced at 10/-, should prove of value to all interested in the production or supply of screw threads to standards with which they are not familiar, and especially to engineering students.



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Dual-Purpose Bronze Valves

Hopkinsons' "S.T.S." bronze valves, with their mitre-faced valve heads and seats are suitable for use as either isolating or regulating valves. Note how the tapering metal-to-metal joint between body and seat helps to ensure complete fluid-tightness. This range of small valves, in fact, is acknowledged by users to be exceptional for maintaining tightness over very long periods of service, so simply are they designed and so sturdily made.

Available in sizes ¼ in. to 3 in. bore with screwed connections, and ½ in. to 3 in. bore with flanged connections.

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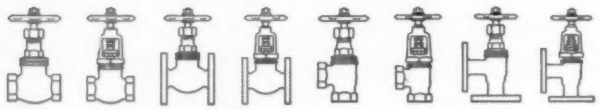

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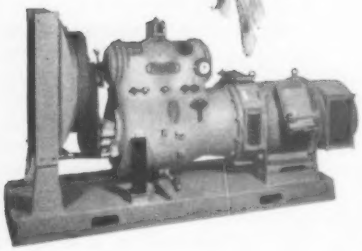
how many people know ?. . .



That the Hydrovane Compressor in relation to the reciprocating or rotary compressor is: More compact . Fewer working parts . Supplies oil free air at much lower temperatures than previously obtainable . Light and self-contained Lower power consumption . Lower initial cost. *Please write for fully illustrated brochure.*

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Barrow-in-Furness. Zenith Carburettor Co. Limited. A contract for the erection of a factory has been let to John Laing and Son, Dalston Road, Carlisle.

Bishop Auckland. Wilson's Forge. Plans for new office block are being prepared by M. C. Robson and Son, Station Chambers.

Commercial and Suburban Properties Limited, New Bond Street, London, W.1., propose shops in Newgate Street to plans by Morris De Metz, 20 Gloucester Place, Portman Square, London, W.1.

Carlisle. The West Cumberland Farmers Trading Society Limited, Whitehaven, are to erect poultry packing station at Harraby Green, to plans by Graham, Roy and Nicholson, 6 Paternoster Row, Carlisle.

Gleneden Textiles Limited. The architect for office additions in Milbourne Street is G. W. Danson, 54 Lowther Street, Carlisle.

Crook (Co. Durham). The West Hunwick Silica and Firebrick Co. Limited are to spend £250,000 on extensions to their brickworks. The scheme includes new preparation plant and tunnel kiln for the making of basic refractory materials, and contracts have been awarded.

Darlington. Stephenson and Hawthorn Limited. Plans have been prepared for additions to locomotive building shops at Springfield Road.

Whessoe Limited. Plans prepared for building a new welding shop.

C. H. Pugh Limited. Plans prepared by E. G. Crofts, 49 Grange Road, Darlington, for factory on McMullen Road trading estate.

Gateshead. Scala Cinema, High Street. The contract for converting the cinema into eight shops and offices has been awarded to Richard Costain Limited, 16 Great North Road, Newcastle upon Tyne.

Middlesbrough. R. Collier, Grange Road, Middlesbrough. The architects for dairy on the Simpson Street lighting industrial estate are Elder and Lester, 65 Albert Road.

Newcastle upon Tyne. H. Rowe Limited. The contract for building a soft drinks factory at Back Condercum Road has been let to W. N. Howe Limited, Heaton Road.

South Shields. The North Eastern Electricity Board, Carliol House, Newcastle upon Tyne, are to erect offices, storerooms and workshops in Newcastle Road, South Shields. The architects are L. J. Couves and Partners, Grainger Chambers, Hood Street, Newcastle upon Tyne.

Stockton-on-Tees. Miller and Gordon Limited, transporters, Orwell Street, Middlesbrough, are to erect office block, garage and warehouse at Haverton Hill Road industrial site.

Reay Brass Foundry Limited, West Row, Stockton, are to erect foundry 100 ft by 30 ft on the Portrack trading estate, and negotiations are in hand for the purchase of the land.

Sunderland. Petrofina (Great Britain) Limited, London, S.W.1., have placed a contract with Whessoe Limited, Darlington, for the construction of a 5,000 ton oil storage tank on the Corporation Quay, Sunderland.

Redhead and Brown, plumbers and electricians, 169 Roker Avenue, Sunderland, are to erect offices, store and workshop in Hay Street and Wilson Street North. The architect is R. Eggleston, 2 Tunstall Road, Sunderland.

Whickham (Co. Durham). Shield Bros., builders and contractors, Swalwell, are seeking permission to erect offices, workshops and garages on three acres of land at Market Lane, Swalwell. The architects are Mauchlen, Weightman and Elphick, 12 Saville Row, Newcastle upon Tyne.

Belfast. Clarence Engineering Co. Limited 24 Ormeau Avenue. New factory.

Bolton. Thynne Engineers Limited, 33-35 Thynne Street, are considering making extensions to their works.

Bootle. Peter Marsh & Sons, Limited, Dundee Works, Canal Road, are considering extensions to their works.

Brentford. The Firestone Tyre & Rubber Co. Limited, Great West Road, are to extend and modernize their factory.

Brighouse. British Monorail Limited are to extend their works in Wakefield Road.

James Reside Limited. Tower Works, Birds Royd, is to be extended.

Brighton. Dowding & Doll Limited, Crowhurst Road. Extensions to works.

Cardiff. The Rover Car Co. Limited, Meteor Works, Solihull, are seeking a site at Pengam for a new works.

Carlisle. Acco Automatic Co. Limited are to make extensions to their factory on the Durranhill industrial estate.

New Factories

Chelmsford. Eytor Lens Manufacturers Limited, Legg Street. Richard Ferguson, 124 London Road, is the architect for extensions to the works.

Coleraine. Ulster Chipboard Limited, Castleroe. Extensions to works.

Corsham. Altus Engineering Company, Stokes Road. Extensions to factory.

Coventry. Middlemores (Coventry) Limited, 89 Little Park Street. New factory and offices are to be built at Torrington Avenue industrial estate.

Croydon. Carrington Manufacturing Co. Limited, Vulcan Way. Extensions to factory.

Dagenham. Advance Components Limited are to erect a new factory and offices at Roebuck Road, Hainault industrial estate.

Dawley. Ever-Ready Co. (Great Britain) Limited. The factory at Hinkshay Road is to be extended.

Dartford. Illinois Stoker & Combustion Co. Limited. Extensions are to be made to the works in Princes Road.

Dewsbury. J. Reddihough Limited, are to rebuild part of the Spinkwell Mills, Halifax Road.

Dover. London Fancy Box Co. Limited, Granville Street. Extensions to factory.

Dunstable. Wilford Manufacturing Co. Limited, Grange Works, Great Northern Road. Works extensions.

Eastbourne. Photax (London) Limited, 1 Charlotte Street, London W1. New factory to be built at Brampton Park Estate. Mr. H. H. Ford, 24 Cornfield Road, is the architect.

Edmonton. Fleetway Manufacturing Company. Extensions are to be made to the factory in Charlton Road.

Glasgow. Coates Bros. & Co. Limited, New Arterial Road, St. Mary Cray, are to build a new factory in the Glasgow area.

Glossop. Ferrostatics Limited, Borough Works, High Street West. New factory and offices to be built at Surrey Street.

Hanworth. G.B. Cycle Components Limited, Hanworth Trading Estate. New factory to be built at Hampden Road. F. W. Meston, 30 Clewer Hill Road, Windsor, is the architect.

Havant. Ann Howard Limited, 154 Weensland Road, Falkirk. Plans have been approved for the erection of a new factory.

Hull. Weeks & Co. (Engineers) Limited, Oxford Street, are to erect a new factory.

Kidderminster. Henry Beakbane (Dortox) Limited, Stourport. New factory. W. E. Bodenham, 74 Worcester Street, Kidderminster, is the architect.

Larkhall. S. Simpson Limited. Extensions are to be made to the factory. The architects are Wylie, Shanks and Underwood, 12 Clairmount Gardens, Glasgow.

Mansfield. R. L. Jones & Co. Limited, Corporation Street. Factory extensions.

Matlock. North Derbyshire Engineering Co. Limited are to erect a new workshop at Dale Road North, Darley Vale.

Monmouth. Corrugated Fittings Limited, 6 Arlington Street, London, W.1., are to build a new factory.

Portsmouth. Bell Punch Co. Limited, Rodney Road. Extensions to factory.

The Metal Box Co. Limited. Extensions to workshops at Burrfields Road.

Rotherham. Midland Iron Co. Limited, Midland Ironworks. New works in Union Street.

Rotherham Forge & Rolling Mills Limited. Extensions are to be made to the works at Greasborough Lane.

Redditch. Slag Reduction Co. Limited. Extensions are to be made to Templeborough Works, Sheffield Road.

Scarborough. E. T. W. Dennis & Sons Limited are to make extensions to their printing works in Melrose Street.

Sutton Coldfield. S. &. E. Repetition Limited. Extensions to the factory on Reddicap Estate.

Alexander Controls Limited. Extensions to the factory in Reddicap Estate.

Worthing. Quick Release Terminals Limited, 26 Norman Crescent, Shoreham. Factory to be built at Northbrook Road.

Aberdeen. Scottish Agricultural Industries Limited are to reconstruct their Sandilands Chemical Works at a cost of £1M. The plant will be converted to make complete fertilisers and the work should be finished by 1962.

Arbroath. The Metal Box Co. Limited of 37 Baker Street, London, have received Dean of Guild approval for an extension to their £250,000 factory now under construction at Dundee Road, Arbroath. The new development is a further 40 ft wide bay, costing £35,000.

Cumbernauld. Rubery Owen Limited are considering location of a motor accessories factory at Cumbernauld. The plant will be built by the County Council.

Kirkintilloch. H. G. Goudie, knitwear manufacturers, Cowlairs Road, Springburn, Glasgow, are to build a £20,000 factory on a site at Broadcroft.

Leven, Fife. Henry Balfour & Co. Limited of Durie Foundry are to erect a £250,000 boilershop at Mountfleurie near their new laboratories and research centre. They also plan a new metal products shop at their older Durie Foundry, Leven, and a wide variety of other projects. A total expenditure of £500,000 is planned over the next 18 months.

Scunthorpe, Yorkshire. Scottish Agricultural Industries Limited are to build a new £500,000 basic slag works adjoining Richard Thomas & Baldwins Limited. They will process slag from the works to the extent of 120,000 tons annually.

Ashchurch. Dowty Seals Limited manufacturers of precision seals and rubber and plastic mouldings for industry, are undertaking a major reconstruction programme.

Desford. Tube Investments announces a £3 million project for doubling the capacity of the highly mechanized plant of its subsidiary, Tubes Limited, for the production of ball bearing and other heavy duty alloy steel tubes.

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Machinery, Plant and Accessories For Sale

NEW 200-TONS PRESS BRAKE IMMEDIATE DELIVERY, subject to prior sale. Thickness formed ¼ in. × 167 in. over 2 in. die opening. Maximum working length 13 ft 11 in. Between uprights 11 ft 8 in. Steel plate construction. Motor drive. Weight about 25½ tons. An excellent machine. Full details, illustrations, from F. J. EDWARDS LIMITED, 359, Euston Road, London NW1 or 41, Water Street, Birmingham 3.

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PUMPS for all purposes. R. L. Christiansen Limited, Wordesley, Stourbridge. Brierley Hill 78184/5.

Patents For Sale or License

THE Proprietors of Patent No. 709928 for "Diaphragm Structure and Device Embodying it", desire to secure commercial exploitation by Licence or otherwise in the United Kingdom. Replies to Haseltine Lake & Co., 28 Southampton Buildings, Chancery Lane, London WC2.

THE Proprietors of Patent No. 708553 for "Improvements in or relating to Flexible Couplings" desire to secure commercial exploitation by Licence or otherwise in the United Kingdom. Replies to Haseltine Lake & Co., 28 Southampton Buildings, Chancery Lane, London WC2.

Classified advertisements are inserted at the rate of 3/– per line.

THE proprietor of British Patent No. 772370, entitled "Improvements in and Relating to Web Winding Cutters", offers same for License or otherwise to ensure its practical working in Great Britain. Inquiries to Singer, Stern & Carlberg, Chrysler Building New York 17, New York, U.S.A.

THE proprietors of Patent No. 761633 for "Pawl and Ratchet Mechanism for Transforming Mechanical Vibrations into a Rotary Movement for Actuating a Watch or Clock Mechanism" desire to secure commercial exploitation by Licence or otherwise in the United Kingdom. Replies to Haseltine Lake & Co., 28, Southampton Buildings, Chancery Lane, London WC2.

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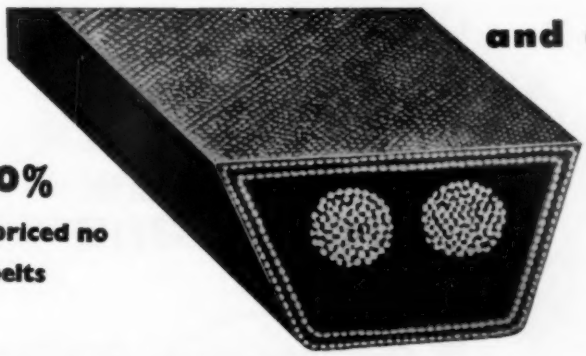

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Titanium Alloys	up to 8 sq. ins. cross sectional area
"Nimonic" 75	up to 5½ sq. ins. cross sectional area
"Nimonic" 80a	up to 3½ sq. ins. cross sectional area
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Welding capacity in Steel Tubes of diameters up to 6½ ins. and cross section area of 8 sq. ins. maximum.

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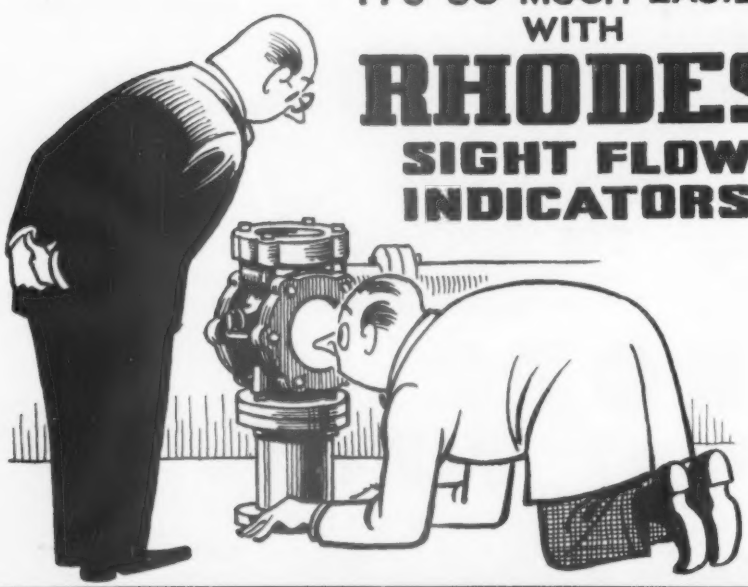

Fig. No. 401, Right Angle Type, internal 45° spout and large window areas enable smallest quantities of flow to be readily observed. Plug holes tapped ½" B.S.P. are suitable for standard brass case thermometer.

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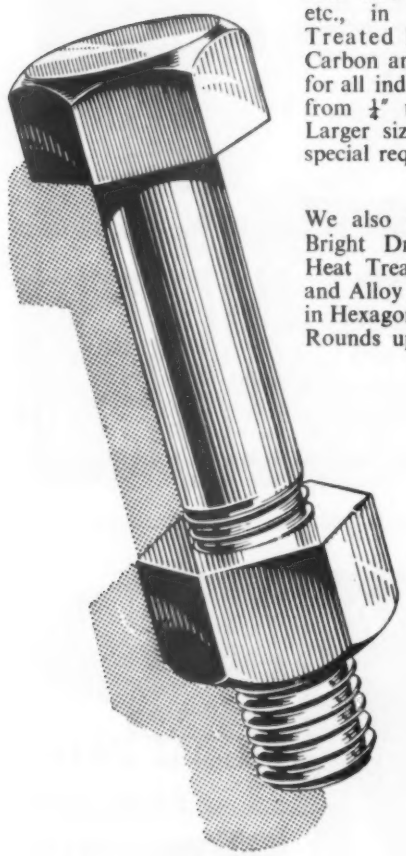
We also manufacture Bright Drawn Heat Treated Carbon and Alloy Steel Bars in Hexagons, Squares and Rounds up to 3½" dia.



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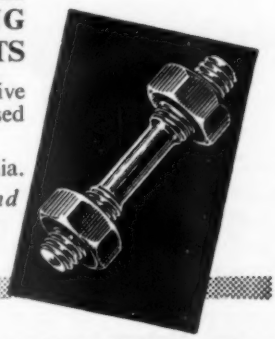

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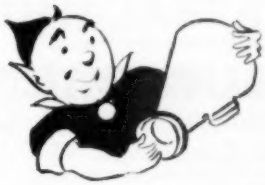

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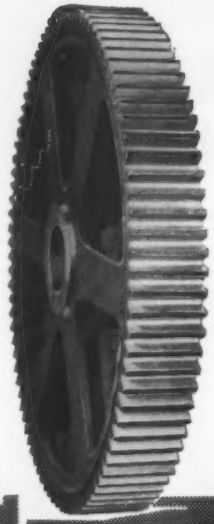

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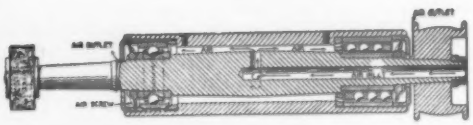

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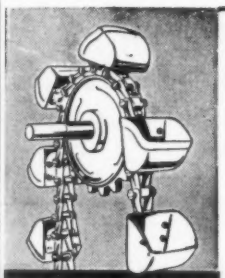

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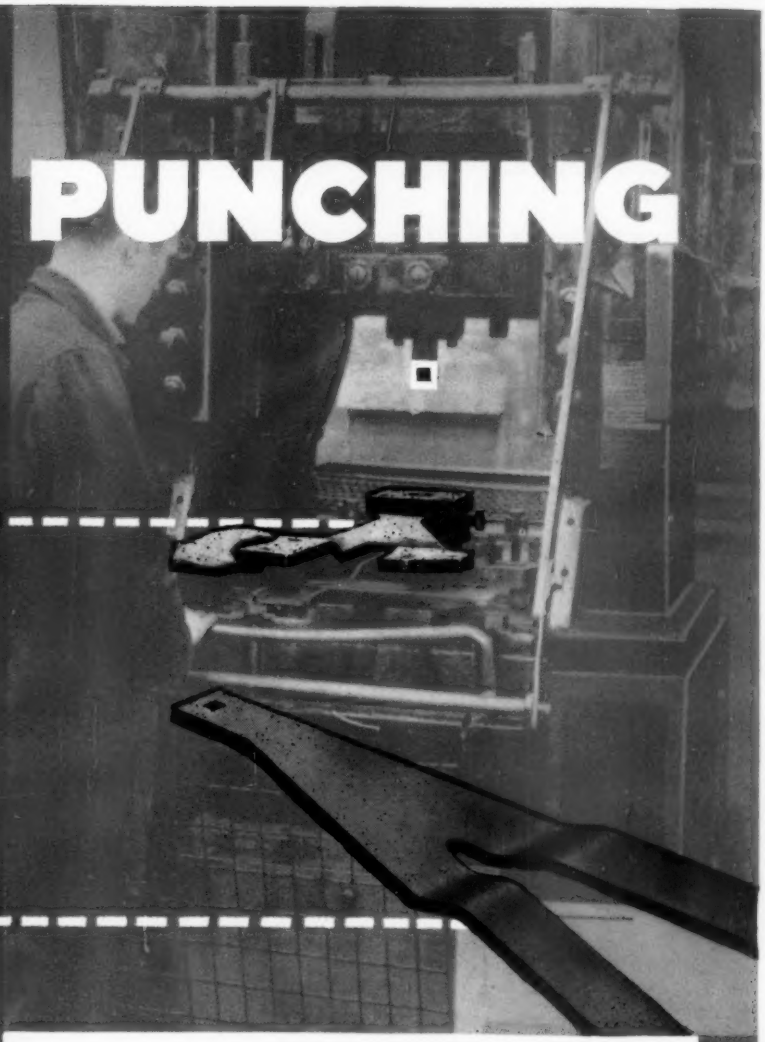

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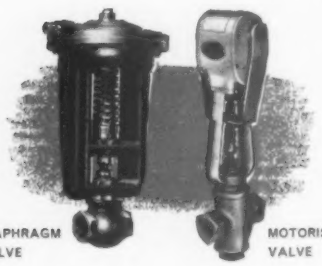

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